CONSUMER SEMICONDUCTOR

DATABOOK

INTRODUCTION

This databook contains data sheets on the SGS-ATES range of small signal transistors and integrated circuits intended for consumer applications.
To permit ease of consultation, this book has been divided into four main sections:
General Information, Germanium Transistors, Silicon Transistors, and Integrated Circuits.
The General Information section contains definitions of symbols and terms used in order to facilitate correct technical interpretation of the data sheets, as well as an alphanumerical list of types.
The information on each product has been specially presented in order that the performance of the product can be readily evaluated within any required equipment design.
An arrow (→) at left hand side of table indicates parameter which has been modified since previous data sheet issue.

OTHER SGS-ATES DATABOOKS

Data sheets on the SGS-ATES range of discrete devices and integrated circuits for professional applications, and high power devices for professional and consumer applications can be found in the following databooks:

SGS-ATES Professional Semiconductor Databook 1 (discrete devices)

SGS-ATES Professional Semiconductor Databook 2 (integrated circuits)

SGS-ATES Power Semiconductor Databook

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GENERAL INFORMATION

GERMANIUM TRANSISTORS

SILICON TRANSISTORS

INTEGRATED CIRCUITS

GENERAL INFORMATION

1. LETTER SYMBOLS FOR SEMICONDUCTOR DEVICES

(referred to diodes, transistors and linear integrated circuits)

1.1. QUANTITY SYMBOLS

a. Instantaneous values of current, voltage and power, which vary with time are represented by the appropriate lower case letter.

Examples: i, v, p

b. Maximum (peak), average, d.c. and root-mean-square values are represented by appropriate upper case letter.

Examples: I, V, P

1.2. SUBSCRIPTS FOR QUANTITY SYMBOLS

a. Total values are indicated by upper case subscripts.

Examples: I_C, i_C, V_{EB}, P_C, p_C

b. Values of varying components are indicated by lower case subscripts.

Examples: i_c, I_c, v_{eb}, p_c; P_c

c. To distinguish between maximum (peak), average, d.c. and root-mean-square values, it is possible to represent maximum and average values adding the subscripts m or M and respectively av or AV.

Examples: I_{cm}, I_{CM}, I_{cav}, I_{CAV}

It is possible to represent R.M.S. values by adding the subscripts (rms) and (RMS)

Examples: $I_{c\ (rms)}$, $I_{C\ (RMS)}$

d. List of subscripts (for examples see figure 1 and the fundamental symbols schedule e.)

A, a = Anode terminal

K, k = Cathode terminal

E, e	=	Emitter terminal
B, b	=	Base terminal
C, c	=	Collector terminal
J, j	=	Generic terminal
(BR)	=	Primary break-down
X, x	=	Specified circuit
M, m	=	Maximum (peak) value
Min, min	=	Minimum value
AV, av	=	Average value
(RMS), (rms)	=	R.M.S. value
F, f	=	Forward
R, r	=	As first subscript: Reverse. As second subscript: Repetitive
O, o	=	As third subscript: The terminal not mentioned is open circuited
S, s	=	As second subscript: Non repetitive. As third subscript: Short circuit between the terminal not mentioned and the reference terminal
Z	=	Zener. (Replaces R to indicate the actual zener voltage, current or power of voltage reference or voltage regulator diodes)

e. Fundamental symbols schedule (meaning of symbol with subscript)

	i v p	I V P
e b c	istantaneus value of the variable component	R.M.S. value of the variable component, or (with appropriate supplementary subscripts) the maximum or average value (direct current) of the variable component
E B C	istantaneus total value	average value (direct current and without signal) or (with appropriate supplementary subscripts) the total average value (with signal), or the total maximum value

f. Examples of the application of the rules:

Figure 1 represents a transistor collector current, consisting of a direct current and a variable component as a function of time.

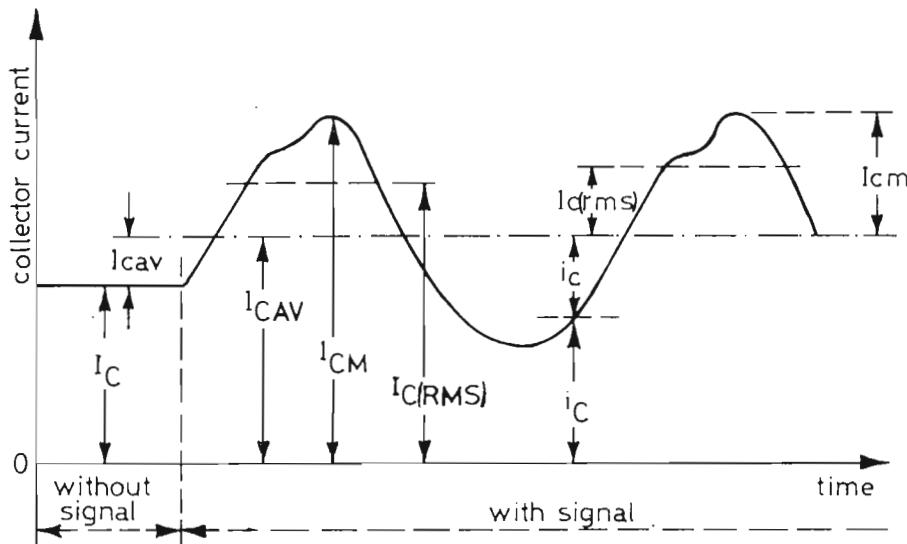



fig. 1

I_C	- DC value, no signal
I_{CAV}	- Average total value
I_{CM}	- Maximum total value
$I_{C(RMS)}$	- R.M.S. total value
I_{cav}	- Average value of the variable component
$I_{c\,(rms)}$	- R.M.S. value of the variable component
I_{cm}	- Maximum value of the variable component
i_C	- Instantaneous total value
i_c	- Instantaneous volue of the variable component

1.3. CONVENTIONS FOR SUBSCRIPT SEQUENCE

a. Currents

For transistor the first subscript indicates the terminal carrying the current (conventional current flow from the external circuit into the terminal is positive).

Instead for diodes a forward current (conventional current flow into the

anode terminal) is represented by the subscript F or f; a reverse current (conventional current flow out of the anode terminal) is represented by the subscript R or r.

b. Voltages

For transistors normally, two subscripts are used to indicate the points between which the voltage is measured. The first subscript indicates one terminal point and the second the reference terminal.
Where there is no possibility of confusion, the second subscript may be omitted.
Instead for diodes a forward voltage (anode positive with respect to cathode) is represented by the subscript F or f and a reverse voltage (anode negative with respect to cathode) by the subscript R or r.

c. Supply voltages
Supply voltages may be indicated by repeating the terminal subscript.

Examples: V_{EE}, V_{CC}, V_{BB}

The reference terminal may then be indicated by a third subscript.

Examples: V_{EEB}, V_{CCB}, V_{BBC}

d. In devices having more than one terminal of the same type, the terminal subscripts are modified by adding a number following the subscript and on the same line.

Example: B_{B2-E} voltage between second base and emitter

In multiple unit devices, the terminal subscripts are modified by a number preceding the terminal subscripts:

Example: V_{1B-2B} voltage between the base of the first unit and that of the second one.

1.4. ELECTRICAL PARAMETER SYMBOLS

a. The values of four pole matrix parameters or other resistances, impedances admittances, etc., inherent in the device, are represented by the lower case symbol with the appropriate subscripts.

Examples: h_{ib}, z_{fb}, y_{oc}, h_{FE}

Note: The symbol of the capacitances that is represented by the upper case (C) is an exception to this rule.

b. The four pole matrix parameters of external circuits and of circuits in which the device forms only a part are represented by the upper case symbols with the appropriate subscripts.

Examples: H_i, Z_o, H_F, Y_R

1.5. SUBSCRIPTS FOR PARAMETER SYMBOLS

a. The static values of parameters are indicated by upper case subscripts.

Examples: h_{IB}, h_{FE}

Note: The static value is the slope of the line from the origin to the operating point on the appropriate characteristic curve, i.e. the quotient of the appropriate electrical quantities at the operating point.

b. The small-signal volues of parameters are indicated by lower case subscripts.

Examples: h_{ib}, Z_{ob}

c. The first subscript, in matrix notation identifies the element of the four pole matrix.

i (for 11) = input

o (for 22) = output

f (for 21) = forward transfer

r (for 12) = reverse transfer

Examples: $V_1 = h_i I_1 + h_r V_2$
$I_2 = h_f I_1 + h_o V_2$

Notes

1 - The voltage and current symbols in matrix notation are indicated by a single digit subscript.
The subscript 1 = input; the subscript 2 = output.

2 - The voltages and currents in these equations may be complex quantities.

d. The second subscript identifies the circuit configuration.

e = common emitter

b = common base

c = common collector

j = common terminal, general

Examples: (common base)

$$I_1 = y_{ib} V_{1b} + y_{rb} V_{2b}$$
$$I_2 = y_{fb} V_{1b} + y_{ob} V_{2b}$$

When the common terminal is understood, the second subscript may be omitted.

e. If it is necessary to distinguish between real and imaginary parts of the four pole parameters, the following notations may be used.

$Re(h_{ib})$ etc... for the real part

$Im(h_{ib})$ etc... for the imaginary part

2. ALPHABETICAL LIST OF SYMBOLS

AMR	Amplitude modulation rejection
B	Bandwidth
b_{fb}	Common-base, forward transfer susceptance (output short-circuited, y matrix)
b_{fe}	Common-emitter, forward transfer susceptance (output short-circuited, y matrix)
b_{ib}	Common-base, input susceptance (output short-circuited, y matrix)
b_{ie}	Common-emitter, input susceptance (output short-circuited, y matrix)
b_{ob}	Common-base, output susceptance (input short-circuited, y matrix)
b_{oe}	Common-emitter, output susceptance (input short-circuited, y matrix)
b_{rb}	Common-base, reverse transfer susceptance (input short-circuited, y matrix)
b_{re}	Common-emitter, reverse transfer susceptance (input short-circuited, y matrix)
$C_{b'c}$	Intrinsic base-collector capacitance
$C_{b'e}$	Intrinsic base-emitter capacitance
C_{CBO}	Collector-base capacitance (emitter open to a.c. and d.c.)
C_{CSS}	Collector-substrate capacitance (emitter and base open to a.c. and d.c.)
C_{EBO}	Emitter-base capacitance (collector open to a.c. and d.c.)
C_i	Input capacitance
C_{ib}	Common-base, input capacitance (output a.c. short-circuited, h and y matrix)
C_{ibo}	Common-base, input capacitance (output a.c. open-circuited)
C_{ie}	Common-emitter, input capacitance (output a.c. short-circuited, h and y matrix)
C_L	Load capacitance
CMRR	Common mode rejection ratio
C_o	Output capacitance

C_{ob}	Common-base, output capacitance (input a.c. short-circuited, y matrix)
C_{obo}	Common-base, output capacitance (input a.c. open-circuited, h matrix)
C_{oe}	Common-emitter, output capacitance (input a.c. short-circuited, y matrix)
C_{oeo}	Common-emitter, output capacitance (input a.c. open-circuited, h matrix)
C_{rb}	Common-base, reverse capacitance (input a.c. short-circuited, y matrix)
C_{re}	Common-emitter, reverse capacitance (input a.c. short-circuited, y matrix)
d	Distortion
e_N	Noise voltage
$E_{s/b}$	Second breakdown energy (with base-emitter junction reverse biased)
f	Frequency
δf	Frequency change or drift
Δf	Frequency deviation
$\frac{\delta f}{\Delta T} \left(\frac{\Delta f}{\Delta T} \right)$	Frequency drift with temperature variation
$\frac{\delta f}{\Delta V} \left(\frac{\Delta f}{\Delta V} \right)$	Frequency drift with voltage variation
f_{hfb}	Common-base, cut-off frequency
f_{hfe}	Common-emitter, cut-off frequency
f_m	Modulation frequency
f_{max}	Maximum oscillator frequency
f_T	Transition frequency
f_{yfe}	Common-emitter cut-off frequency
G_A	Available power gain
G_{AM}	Maximum available power gain
g_{fb}	Common-base, forward transconductance (input short-circuited, y matrix)

g_{fe}	Common-emitter, forward transconductance (input short-circuited, y matrix)
g_{ib}	Common-base, input conductance (output short-circuited, y matrix)
g_{ie}	Common-emitter, input conductance (output short-circuited, y matrix)
g_{ob}	Common-base, output conductance (input short-circuited, y matrix)
g_{oe}	Common-emitter, output conductance (input short-circuited, y matrix)
G_p	Power gain
G_{pb}	Common-base, power gain
G_{pe}	Common-emitter, power gain
G_{pM}	Maximum power gain
g_{rb}	Common-base, reverse transconductance (input short-circuited, y matrix)
g_{re}	Common-emitter, reverse transconductance (input short-circuited, y matrix)
G_{SM}	Maximum stable power gain
G_{tr}	Transducer power gain
G_U	Unilateralized power gain
G_{UM}	Maximum unilateralized power gain
G_v	Voltage gain
h_{fb}	Common-base, small-signal value of the short-circuit forward current transfer ratio
h_{fe}	Common-emitter, small-signal value of the short-circuit forward current transfer ratio
h_{FE}	Common-emitter, static value of the forward current transfer ratio
h_{FE1}/h_{FE2}	Common-emitter, static value of the forward current transfer matched pair ratio
h_{ib}	Common-base, small-signal value of the short-circuit input impedance
h_{ie}	Common-emitter, small-signal value of the short-circuit input impedance
h_{ob}	Common-base, small-signal value of the open-circuit output admittance
h_{oe}	Common-emitter, small-signal value of the open-circuit output admittance

h_{rb}	Common-base, small-signal value of the open-circuit reverse voltage transfer ratio
h_{re}	Common-emitter, small-signal value of the open-circuit reverse voltage transfer ratio
I_b	Bias current
I_B	Base current
I_{B1}	Turn-on current
I_{B2}	Turn-off current
$\|I_{B1}-I_{B2}\|$	Input offset current
I_{BF}	Base forward current
I_{BFM}	Base forward peak current
I_{BM}	Base peak current
I_{BR}	Base reverse current
I_{BRM}	Base reverse peak current
I_C	Collector current
I_{CBO}	Collector cut-off current with emitter open
I_{CBV}	Collector cut-off current with specified reverse voltage between emitter and base
I_{CEO}	Collector cut-off current with base open
I_{CER}	Collector cut-off current with specified resistance between emitter and base
I_{CES}	Collector cut-off current with emitter short-circuited to base
I_{CEV}	Collector cut-off current with specified reverse voltage between emitter and base
I_{CEX}	Collector cut-off current with specified circuit between emitter and base
I_{CM}	Collector peak current
I_d	Drain current
I_E	Emitter current
I_{EBO}	Emitter cut-off current with collector open
i_N	Noise current
I_o	Output current
I_s	Supply current

I_{sc}	Output current during output short-circuit
$I_{s/b}$	Second breakdown collector current (with base-emitter junction forward biased)
I_z	Zener current
m	Modulation factor
NF	Noise figure
NF_c	Conversion noise figure
P_o	Output power of a specified circuit
PRT	Power ratio test
P_{tot}	Total power dissipation
$r_{bb'}$	Base spreading resistance
$r_{bb'}C_{b'c}$	Feedback time constant
R_{BB}	Base dropping resistance
R_{BE}	Resistance between base and emitter
R_{CC}	Collector dropping resistance
R_{EE}	Emitter dropping resistance
R_g	Internal resistance of generator
R_i	Input resistance
R_L	Load resistance
R_o	Output resistance
R_{th}	Thermal resistance
$R_{th\ j\text{-}amb}$ ($R_{th\ j\text{-}a}$)	Thermal resistance junction-to-ambient
$R_{th\ j\text{-}case}$ ($R_{th\ j\text{-}c}$)	Thermal resistance junction-to-case
r_z	Dynamic zener resistance
$\frac{S+N}{N}$	Signal and noise to noise ratio
SR	Slew rate
SVR	Supply voltage rejection
t	Time
T_{amb} (T_a)	Ambient temperature
T_{case} (T_c)	Case temperature
t_d	Delay time

t_f	Fall time
T_j	Junction temperature
T_l	Lead temperature
t_{off}	Turn-off-time
t_{on}	Turn-on-time
T_{op}	Operating temperature
t_p	Pulse time
t_r	Rise time
t_s	Storage time
T_{stg} (T_s)	Storage temperature
$\frac{\Delta V}{\Delta T}$	Voltage drift with temperature variation
$\frac{\Delta V}{V}$	Relative voltage variation
V_{BE}	Base-emitter voltage
$V_{BE\,(sat)}$	Base-emitter saturation voltage
$V_{BE1}-V_{BE2}$	Base-emitter voltage difference
$\lvert V_{BE1}-V_{BE2}\rvert$	Input offset voltage
$\frac{\lvert V_{BE1}-V_{BE2}\rvert}{\Delta T}$	Input-offset voltage temperature coefficient
$V_{(BR)\,CBO}$	Collector-base breakdown voltage with emitter open
$V_{(BR)\,CEO}$	Collector-emitter breakdown voltage with base open
$V_{(BR)\,CER}$	Collector-emitter breakdown voltage with specified resistance
$V_{(BR)\,CES}$	Collector-emitter breakdown voltage with emitter short-circuited to base
$V_{(BR)\,CEV}$	Collector-emitter breakdown voltage with specified reverse voltage between emitter and base
$V_{(BR)\,EBO}$	Emitter-base breakdown voltage with collector open
V_{CB}	Collector-base voltage
V_{CBO}	Collector-base voltage with emitter open
V_{CBV}	Collector-base voltage with specified reverse voltage between emitter and base
V_{CE}	Collector-emitter voltage

V_{CEK}	Knee voltage at specified condition
$V_{CEK\,(HF)}$	High frequency knee voltage at specified condition
V_{CEO}	Collector-emitter voltage with base open
$V_{CEO\,(sus)}$	Collector-emitter sustaining voltage with base open
V_{CER}	Collector-emitter voltage with specified resistance between emitter and base
$V_{CER\,(sus)}$	Collector-emitter sustaining voltage with specified resistance between emitter and base
$V_{CE\,(sat)}$	Collector-emitter saturation voltage
V_{CES}	Collector-emitter voltage with emitter short-circuited to base
$V_{CES\,(sus)}$	Collector-emitter sustaining voltage with emitter short-circuited to base
V_{CEV}	Collector-emitter voltage with specified reverse voltage between emitter and base
$V_{CEV\,(sus)}$	Collector-emitter sustaining voltage with specified reverse voltage between emitter and base
V_{CEX}	Collector-emitter voltage with specified circuit between emitter and base
$V_{CEX\,(sus)}$	Collector-emitter sustaining voltage with specified circuit between emitter and base
V_{CSS}	Collector-substrate voltage
V_{EB}	Emitter-base voltage
V_{EBO}	Emitter-base voltage with collector open
V_i	Input voltage of a specified circuit
$V_{i(threshold)}$	Input limiting voltage
V_{int}	Interfering voltage
V_o	Output voltage of a specified circuit
V_{pp}	Peak-to-peak voltage
V_{pt}	Punch-through voltage
V_{ref}	Reference voltage
V_s	Supply voltage
V_z	Zener voltage
y_{fb}	Common-base, small-signal value of the short-circuit forward transfer admittance

y_{fe} — Common-emitter, small-signal value of the short-circuit forward transfer admittance

y_{ib} — Common-base, small-signal value of the short-circuit input admittance

y_{ie} — Common-emitter, small-signal value of the short-circuit input admittance

y_{ob} — Common-base, small-signal value of the short-circuit output admittance

y_{oe} — Common-emitter, small-signal value of the short-circuit output admittance

y_{rb} — Common-base, small-signal value of the short-circuit reverse transfer admittance

y_{re} — Common-emitter, small-signal value of the short-circuit reverse transfer admittance

Z_{BE} — Impedance between base and emitter

Z_i — Input impedance

Z_o — Output impedance

η — Efficiency

η_C — Collector efficiency

τ_s — Storage time constant

φ_{fb} — Common-base, phase angle of the forward transadmittance (output short-circuited, y matrix)

φ_{fe} — Common-emitter, phase angle of the forward transadmittance (output short-circuited, y matrix)

φ_{ib} — Common-base, phase angle of the input admittance (output short-circuited, y matrix)

φ_{ie} — Common-emitter, phase angle of the input admittance (output short-circuited, y matrix)

φ_{ob} — Common-base, phase angle of the output admittance (input short-circuited, y matrix)

φ_{oe} — Common-emitter, phase angle of the output admittance (input short-circuited, y matrix)

φ_{rb} — Common-base, phase angle of the reverse transadmittance (input short-circuited, y matrix)

φ_{re} — Common-emitter, phase angle of the reverse transadmittance (input short-circuited, y matrix)

3. RATING SYSTEMS FOR ELECTRONIC DEVICES

3.1. DEFINITIONS OF TERMS USED

a. **Electronic device.** An electronic tube or valve, transistor or other semi-conductor device.
Note: This definition excludes inductors, capacitors, resistors and similar components.

b. **Characteristic.** A characteristic is an inherent and measurable property of a device. Such a property may be electrical, mechanical, thermal, hydraulic, electro-magnetic, or nuclear, and can be expressed as a value for stated or recognized conditions. A characteristic may also be a set of related values, usually shown in graphical form.

c. **Bogey electronic device.** An electronic device whose characteristics have the published nominal values for the type. A bogey electronic device for any particular application can be obtained by considering only those characteristics which are directly related to the application.

d. **Rating.** A value which establishes either a limiting capability or a limiting condition for an electronic device. It is determinated for specified values of environment and operation, and may be stated in any suitable terms.
Note: Limiting conditions may be either maxima or minima.

e. **Rating system.** The set of principles upon which ratings are established and which determins their interpretation.
Note: The rating system indicates the division of responsibility between the device manufacturer and the circuit designer, with the object of ensuring that the working conditions do not exceed the ratings.

3.2. ABSOLUTE MAXIMUM RATING SYSTEM

Absolute maximum ratings are limiting values of operating and environmental conditions applicable to any electronic device of a specified type as defined by its published data, which should not be exceeded under the worst probable conditions.
These values are chosen by the device manufacturer to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the device under consideration and of all other electronic devices in the equipment.
The equipment manufacturer should design so that, initially and throughout life, no absolute maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply voltage variation, equipment component variation, equipment control adjustment, load variations, signal variation, environmental conditions, and variations in characteristics of the device under consideration and of all other electronic devices in the equipment.

3.3. DESIGN - MAXIMUM RATING SYSTEM

Design-maximum ratings are limiting values of operating and environmental conditions applicable to a bogey electronic device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

These values are chosen by the device manufacturer to provide acceptable serviceability of the device, taking responsibility for the effects of changes in operating conditions due to variations in the characteristics of the electronic device under consideration.

The equipment manufacturer should design so that, initially and throughout life, no design-maximum value for the intended service is exceeded with a bogey device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, variation in characteristics of all other devices in the equipment, equipment control adjustment, load variation, signal variation and environmental conditions.

3.4. DESIGN - CENTRE RATING SYSTEM

Design-centre ratings are limiting values of operating and environmental conditions applicable to a bogey electronic device of a specified type as defined type as defined by its published data, and should not be exceeded under normal conditions.

These values are chosen by the device manufacturer to provide acceptable serviceability of the device in average applications, taking responsibility for normal changes in operating conditions due to rated supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of all electronic devices.

The equipment manufacturer should design so that, initially, no design-centre value for the intended service is exceeded with a bogey electronic device in equipment operating at the stated normal supply-voltage.

The Absolute Maximum Rating System is commonly used for semiconductor devices.

4. TYPE DESIGNATION CODE

4.1. FOR DISCRETE DEVICES

The type number for "discrete" semiconductor devices consists of:
TWO LETTERS FOLLOWED BY A SERIAL NUMBER

The first letter gives information about the **material** used for the active part of the devices:

A Material with a band gap of 0.6 to 1.0eV, such as germanium
B Material with a band gap of 1.0 to 1.3eV, such as silicon
C Material with a band gap of 1.3eV and more, such as gallium arsenide
D Material with a band gap of less than 0.6eV, such as indium antimonide
R Compound material as employed in Hall generators and photoconductive cells, such as cadmium-sulphide, lead-selenide

The second letter indicates the **function** according with the applications and the construction:

A Detection diode, switching diode, mixer diode
B Variable capacitance diode
C Transistor for a.f. applications (Rth j-case>15°C/W)
D Power transistor for a.f. applications (Rth j-case≤15°C/W)
E Tunnel diode
F Transistor for h.f. applications (Rth j-case>15°C/W)
G Multiple of dissimilar devices (1); Miscellaneous
H Magnetic sensitive diode; Field probe
K Hall generator in an open magnetic circuit, e.g. magnetogram or signal probe
L Power transistor for h.f. applications (Rth j-case≤15°C/W)
M Hall generator in a closed electrically energised magnetic circuit, e.g. Hall modulator or multiplier
P Radiation sensitive device
Q Radiation generating device
R Electrically triggered controlling and switching device having a breakdown characteristic (Rth j-case>15°C/W)
S Transistor for switching applications (Rth j-case>15°C/W)
T Electrically, or by means of light, triggered controlling and switching power device having a breakdown characteristic (Rth j-case≤15°C/W)
U Power transistor for switching applications (Rth j-case≤15°C/W)
X Multiplier diode, e.g. varactor, step recovery diode
Y Rectifying diode, booster diode, efficiency diode
Z Voltage reference or voltage regulator diode

1) A multiple device is defined as a combination of similar or dissimilar active devices, contained in a common encapsulation that cannot be dismantled, and of which all electrodes of the individual devices are accessible from the outside.
Multiples of similar devices as well as multiples consisting of a main device and an auxiliary device are designated according to the code for the discrete devices described above.
Multiples of dissimilar devices of other nature are designated by the second letter G.

The serial number is formed by:

Three figures for semiconductor devices which are primarily intended for use in domestic equipment.
Two figures and a letter (this letter starts back from z through y, x, etc. bears no signification).

Version letter

A version letter can be used, for instance, for a diode with up-rated voltage, for a sub-division of a transistor type in different gain ranges, a low noise version of an existing transistor and for a diode, transistor, or thyristor with minor mechanical differences, such as finish of the leads, length of the leads etc. The letters never have a fixed meaning, the only exception being the letter R which indicates reverse polarity.

Examples

BC 107 Silicon low power audio frequency transistor primarily intended for domestic equipment
BUY 46 Silicon power transistor for switching applications in professional equipment

4.2. FOR INTEGRATED CIRCUITS

4.2.1. Types designated by three letters and three figures

The integrated circuits are divided in four groups:
— digital types belonging to a family of circuits;
— digital solitary circuits;
— analogue circuits including linear circuits;
— mixed analogue/digital circuits.

Digital Family Types

First two letters:	family
Third letter:	circuit function
First two figures:	serial number
Third figure:	operating ambient temperature

Digital Solitary Types

First letter:	"S"
Second letter:	extension of serial number
Third letter:	circuit function
First two figures:	serial number
Third figure:	operating ambient temperature range

Analogue (Linear) Types

First letter:	"T"
Second and third letter:	extension of serial number
First two figures:	serial number
Third figure:	operating ambient temperature range

Mixed Digital/Analogue Types

First letter:	"U"
Second and third letter:	extension of serial number
First two figures:	serial number
Third figure:	operating ambient temperature range

Function

H Combinatorial circuit
J Bistable or multistable sequential circuit
K Monostable sequential circuit
L Level converter
N Bi-metastable or multi-metastable sequential circuit
Q Read-write memory circuit
R Read only memory circuit
S Sense amplifier with digital output
Y Miscellaneous

Operating ambient temperature range

1 0 to + 70 °C
2 —55 to + 125 °C
3 —10 to + 85 °C
4 +15 to + 55 °C
5 —25 to + 70 °C
6 —40 to + 85 °C
0 It means no temperature range indicated in the type number

If a circuit is published for a wider temperature range, but does not qualify for a higher classification, the figure indicating the narrower temperature range is used.

Version letter

A version letter can be added to a type number of an existing type to indicate a different version of the same type, for instance, encapsulated

in another package, with other interconnections or showing minor differences in ratings or electrical characteristics. The letter **Z** is used to indicate a type with discretionary wiring.

4.2.2. Types designated by three letters and four figures

The serial number can be a four figure number assigned by Pro Electron or the serial number of an existing company number.

The first two letters:

A. FAMILY CIRCUITS

The FIRST TWO LETTERS give information about the family of circuits. These letters can be FA...FZ, GA...GZ, HA... etc.

B. SOLITARY CIRCUITS

The FIRST LETTER divides the solitary circuits into:

S Solitary digital circuits

T Analogue circuits

U Mixed analogue/digital circuits

The SECOND LETTER is a serial letter without any further significance.

The third letter indicates the operational temperature range or another significant characteristic.

The letters B thru F give information about the temperature range (note 1):

B 0 °C to + 70 °C
C —55 °C to + 125 °C
D —25 °C to + 70 °C
E —25 °C to + 85 °C
F —40 °C to + 85 °C

Other "third" letters refer to electrical or mechanical versions of a family and have no fixed meaning. If no temperature range or another characteristic is indicated, the letter A is used as a third letter.

The serial number can be either a 4 figure number assigned by Pro Electron or the serial number (also numbers comprising letters) of an existing company type designation. Company serial numbers of less than 4 figures are completed to a 4 figure number by "0" 's in front of the number.

A version letter can be used to indicate a deviation of a single characteristic of a type, either electrically or mechanically. The letter never has a fixed meaning, the only exception being the letter Z, indicating "custom-wired" devices.

Note 1: If a circuit is published for a wider temperature range, but does not qualify for a higher classification, the letter indicating the narrower temperature range is used.

5. ALPHANUMERICAL LIST OF TYPES

★ new type

GERMANIUM TRANSISTORS

GERMANIUM MESA PNP

AF 106

VHF MIXER/OSCILLATOR

The AF 106 is a germanium mesa PNP transistor in a Jedec TO-72 metal case. It is particularly designed for use as preamplifier mixer and oscillator up to 260 MHz.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-25	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-18	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-0.3	V
I_C	Collector current	-10	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 45\ °C$	60	mW
	at $T_{case} \leq 66\ °C$	60	mW
T_{stg}	Storage temperature	-30 to 75	°C
T_j	Junction temperature	90	°C

MECHANICAL DATA

Dimensions in mm

Shield lead connected to case

TO-72

AF 106

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	400	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	750	°C/W

ELECTRICAL CHARACTERISTICS (T_{case} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	$V_{CB} = -12$ V			-10	μA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage ($I_E = 0$)	$I_C = -100$ μA	-25			V
$V_{(BR)\ CEO}$	Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = -500$ μA	-18			V
→ $V_{(BR)\ EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	$I_E = -100$ μA	-0.3			V
V_{BE}	Base-emitter voltage	$I_C = -1$ mA $V_{CE} = -12$ V $I_C = -2$ mA $V_{CE} = -6$ V	-0.25 -0.28	-0.325 -0.34	-0.38 -0.4	V V
h_{FE}	DC current gain	$I_C = -1$ mA $V_{CE} = -12$ V $I_C = -2$ mA $V_{CE} = -6$ V	20	50 70		— —
f_T	Transition frequency	$I_C = -1$ mA $V_{CE} = -12$ V f = 100 MHz		220		MHz
$-C_{re}$	Reverse capacitance	$I_C = -1$ mA $V_{CE} = -12$ V f = 450 kHz		0.45		pF
NF	Noise figure	$I_C = -1$ mA $V_{CE} = -12$ V $R_g = 60\ \Omega$ f = 200 MHz		5.5	7.5	dB
$r_{bb'}, C_{b'c}$	Feedback time constant	$I_C = -1$ mA $V_{CE} = -12$ V f = 2.5 MHz		6		ps
G_{pb}	Power gain	$I_C = -3$ mA $V_{CB} = -10$ V $R_L = 920\ \Omega$ f = 200 MHz	14	17.5		dB

GERMANIUM MESA PNP

AF 109R

VHF PREAMPLIFIER

The AF 109R is a germanium mesa PNP transistor in a Jedec TO-72 metal case. It is designed for use in AGC prestages up to 260 MHz.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-20	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-15	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-0.3	V
I_C	Collector current	-10	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 45\ °C$	60	mW
	at $T_{case} \leq 66\ °C$	60	mW
T_{stg}	Storage temperature	-30 to 75	°C
T_j	Junction temperature	90	°C

MECHANICAL DATA

Dimensions in mm

Shield lead connected to case

TO-72

AF 109R

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	400	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	750	°C/W

ELECTRICAL CHARACTERISTICS (T_{case} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	$V_{CB} = -20$ V		-0.5	-8	μA
I_{CEO}	Collector cutoff current ($I_B = 0$)	$V_{CE} = -15$ V			-500	μA
I_{EBO}	Emitter cutoff current ($I_C = 0$)	$V_{EB} = -0.3$ V			-100	μA
V_{BE}	Base-emitter voltage	$I_C = -1.5$ mA $V_{CE} = -12$ V $I_C = -2$ mA $V_{CE} = -6$ V	-320 -320	-380 -380	-430 -430	mV mV
h_{FE}	DC current gain	$I_C = -1.5$ mA $V_{CE} = -12$ V $I_C = -2$ mA $V_{CE} = -6$ V	20	50 55		— —
$-C_{re}$	Reverse capacitance	$I_C = -1$ mA $V_{CE} = -12$ V f = 450 kHz		0.25		pF
NF	Noise figure	$I_C = -2$ mA $V_{CE} = -12$ V $R_g = 60\ \Omega$ f = 200 MHz			4.8	dB
G_{pb}	Power gain	$I_C = -2$ mA $V_{CE} = -12$ V $R_L = 920\ \Omega$ $R_{EE} = 1$ kΩ f = 200 MHz	13	16.5		dB

AF 139

GERMANIUM MESA PNP

UHF AMPLIFIER

The AF 139 is a germanium mesa PNP transistor in a Jedec TO-72 metal case. It is particularly designed for use in prestages as well as in mixer and oscillator stages up to 860 MHz.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-22	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-15	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-0.3	V
I_E	Emitter current	11	mA
I_C	Collector current	-10	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 45\ °C$	60	mW
	at $T_{case} \leq 66\ °C$	60	mW
T_{stg}	Storage temperature	-30 to 75	°C
T_j	Junction temperature	90	°C

MECHANICAL DATA

Dimensions in mm

Shield lead connected to case

TO-72

AF 139

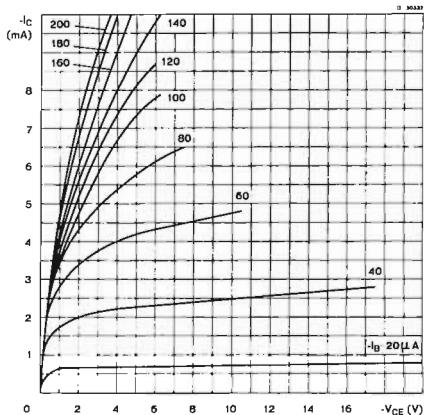
THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	400	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	750	°C/W

ELECTRICAL CHARACTERISTICS (T_{case} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	$V_{CE} = -22$ V			-8	μA
I_{CEO}	Collector cutoff current ($I_B = 0$)	$V_{CE} = -15$ V			-500	μA
I_{EBO}	Emitter cutoff current ($I_C = 0$)	$V_{EB} = -0.3$ V			-100	μA
h_{FE}	DC current gain	$I_C = -1.5$ mA $V_{CE} = -12$ V	10	50		—
f_T	Transition frequency	$I_C = -1.5$ mA $V_{CE} = -12$ V f = 100 MHz		550		MHz
$-C_{re}$	Reverse capacitance	$I_C = -1.5$ mA $V_{CE} = -12$ V f = 100 kHz		0.25		pF
NF*	Noise figure	$I_C = -1.5$ mA $V_{CE} = -12$ V $R_g = 60\ \Omega$ f = 800 MHz		7	8.2	dB
$r_{bb'}, C_{b'c}$	Feedback time constant	$I_C = -1.5$ mA $V_{CE} = -12$ V f = 2.5 MHz		3		ps
G_{pb}*	Power gain	$I_C = -1.5$ mA $V_{CE} = -12$ V $R_L = 1.4\ k\Omega$ f = 800 MHz	9	11		dB

* See test circuit.

Typical output characteristics

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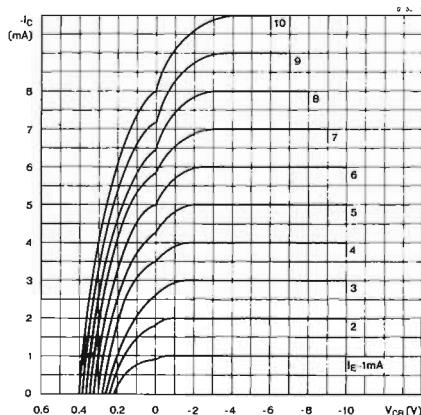
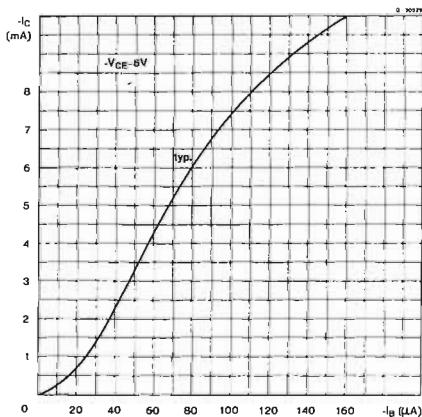
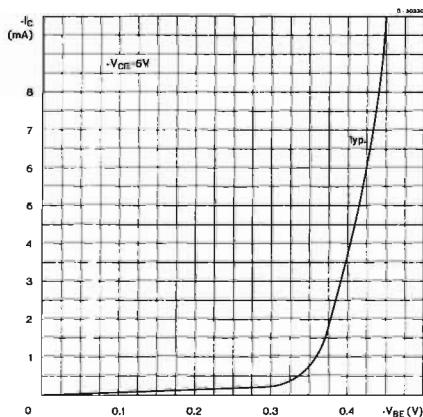
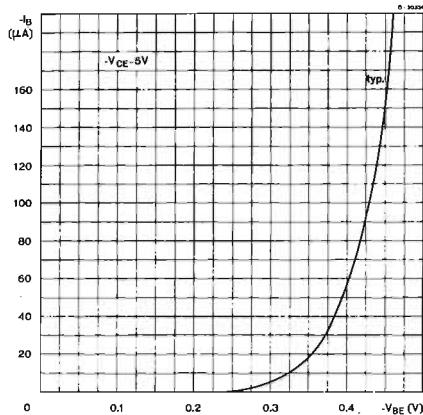
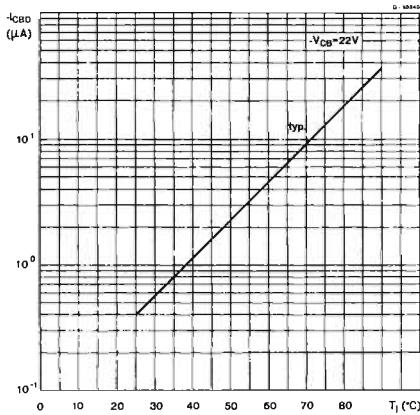
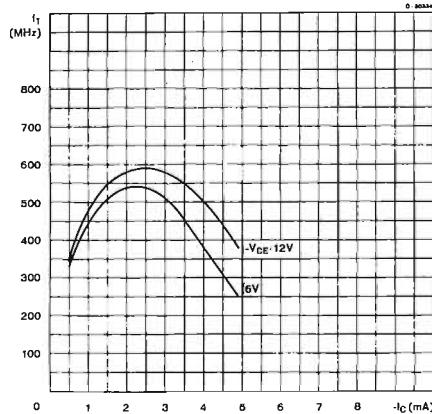
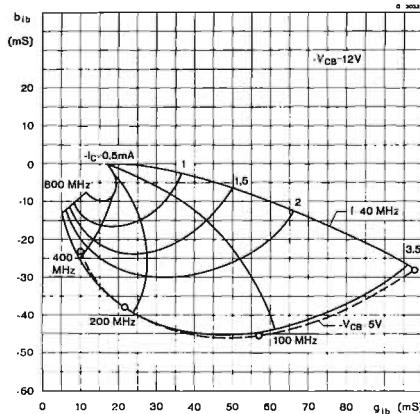
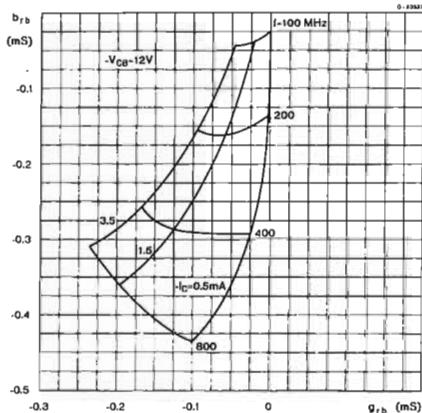
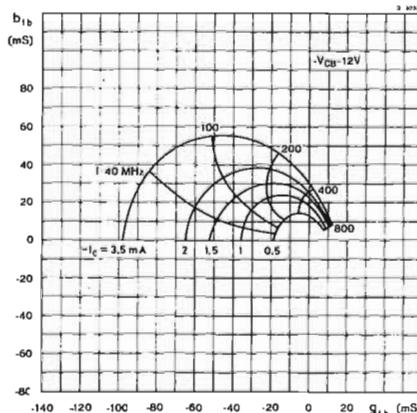
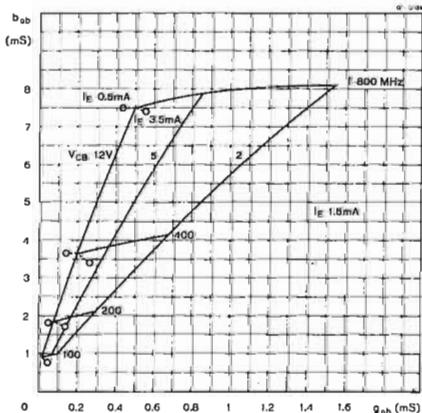
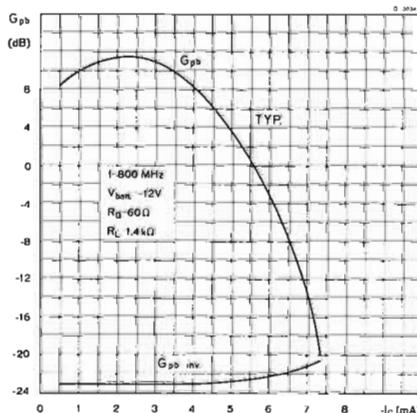
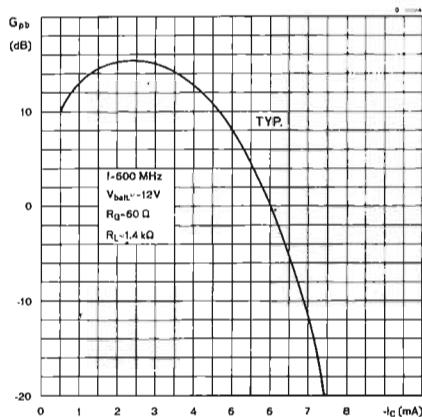
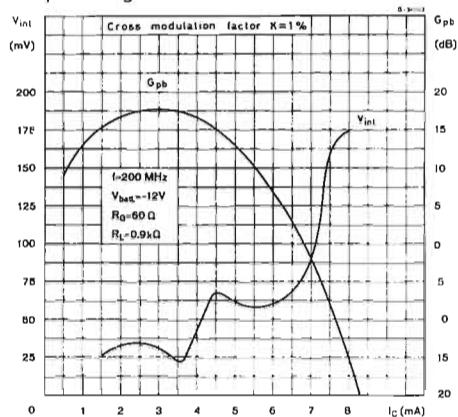
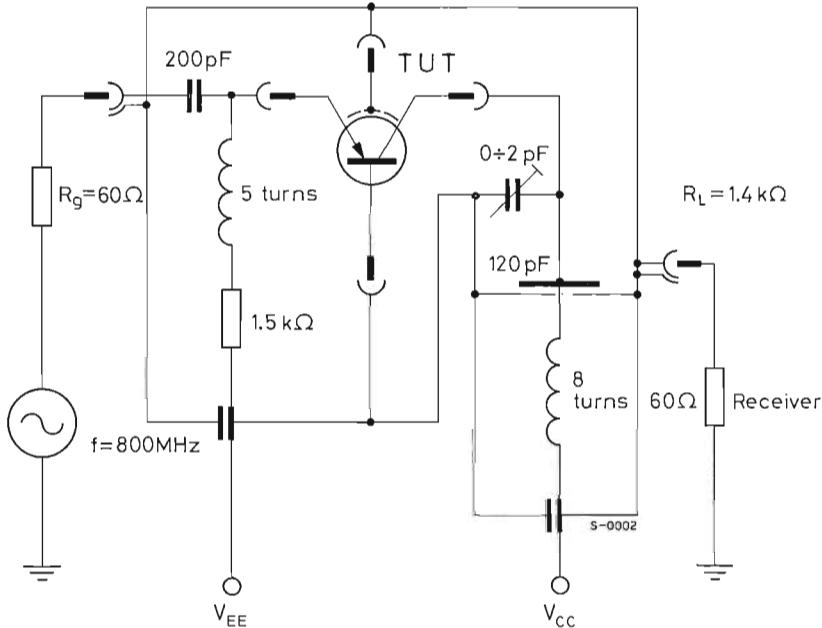

Collector current

DC transconductance

AF 139

Input characteristics

Collector cutoff current

Typical transition frequency

Typical input admittance

Typical reverse admittance

Typical transfer admittance

Typical output admittance

Typical power gain

Power gain

Typical interfering voltage and power gain

TEST CIRCUIT

800 MHz transducer power gain G_{pb} and noise figure test circuit

AF 239

GERMANIUM MESA PNP

UHF PREAMPLIFIER

The AF 239 is a germanium mesa PNP transistor in a Jedec TO-72 metal case. It is particularly designed as preamplifier mixer and oscillator up to 900 MHz.

ABSOLUTE MAXIMUM RATINGS

V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	-20	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-15	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-0.3	V
I_C	Collector current	-10	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 45\,°C$	60	mW
	at $T_{case} \leq 66\,°C$	60	mW
T_{stg}	Storage temperature	-30 to 75	°C
T_j	Junction temperature	90	°C

MECHANICAL DATA

Dimensions in mm

Shield lead connected to case

TO-72

6/68

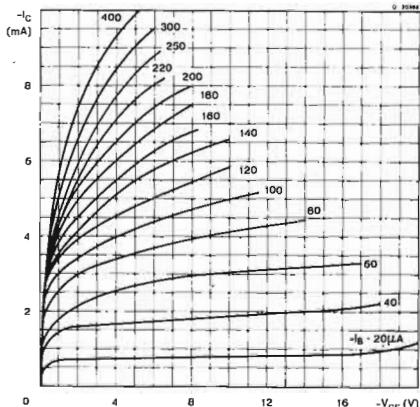
AF 239

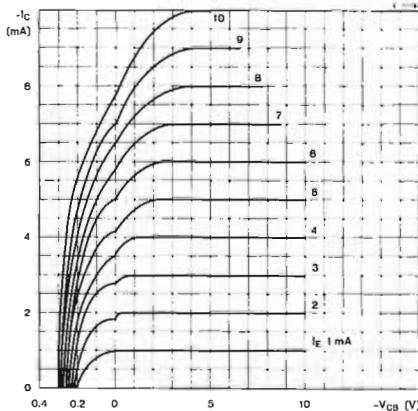
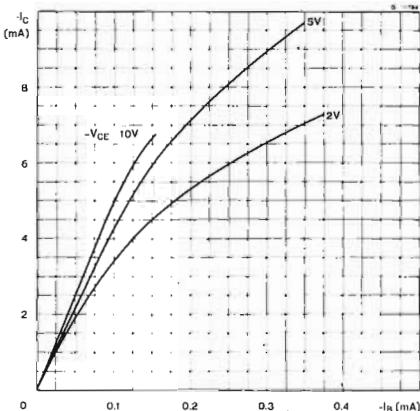
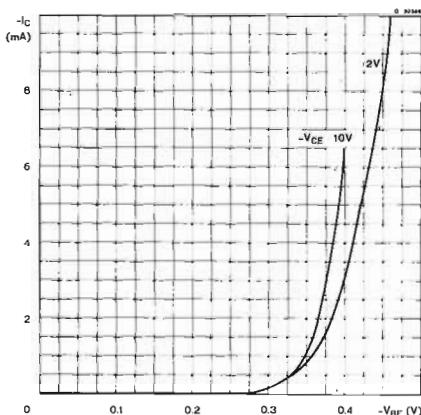
THERMAL DATA

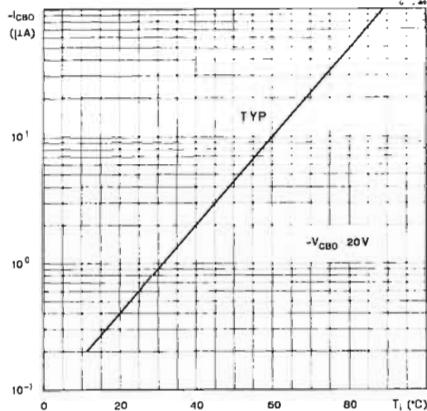
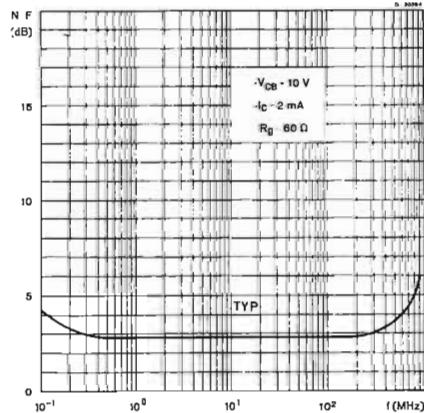
$R_{th\ j-case}$	Thermal resistance junction-case	max	400	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	750	°C/W

ELECTRICAL CHARACTERISTICS (T_{case} = 25 °C unless otherwise specified)

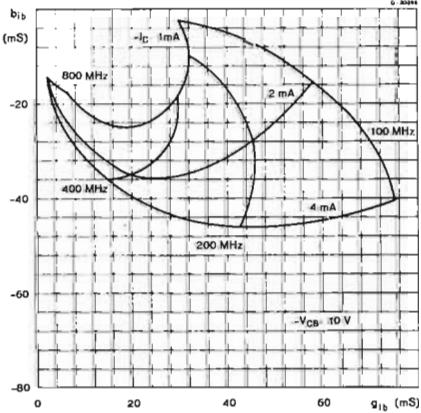
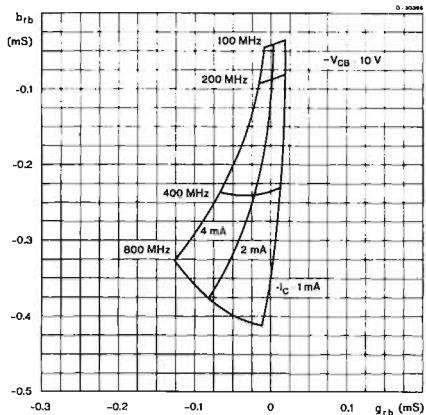
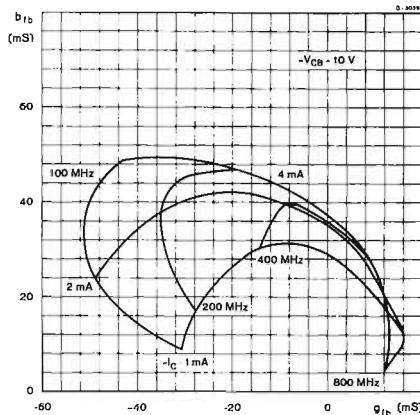
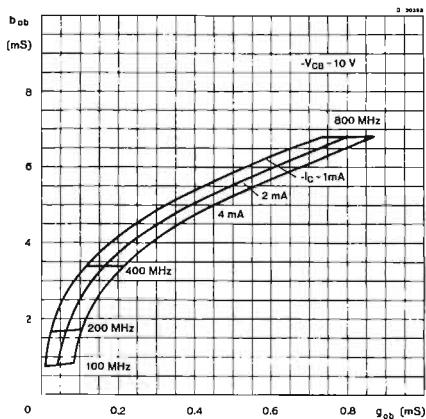
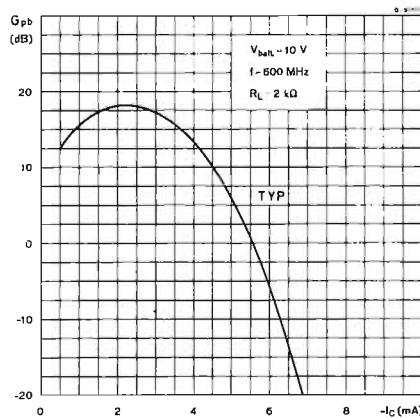
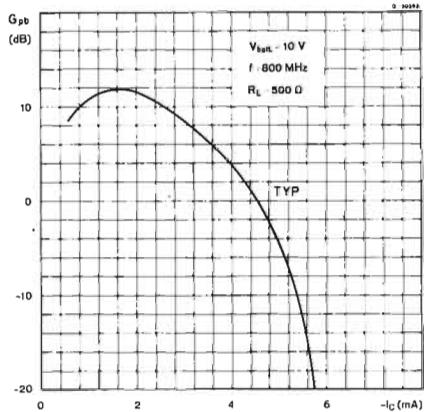
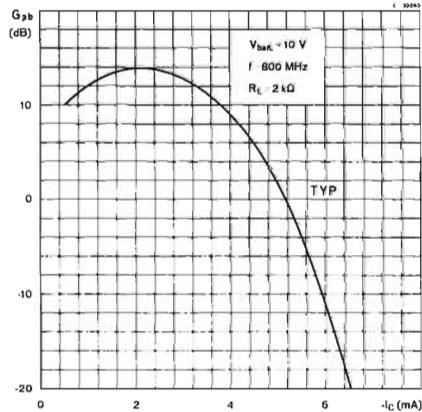
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = -20 V			-8	μA
I_{CEO}	Collector cutoff current (I_B = 0)	V_{CE} = -15 V			-500	μA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = -0.3 V			-100	μA
V_{BE}	Base-emitter voltage	I_C = -2 mA V_{CE} = -10 V I_C = -5 mA V_{CE} = -5 V		-350 -400		mV mV
h_{FE}	DC current gain	I_C = -2 mA V_{CE} = -10 V I_C = -5 mA V_{CE} = -5 V	10	 30		— —
f_T	Transition frequency	I_C = -2 mA V_{CE} = -10 V f = 100 MHz		700		MHz
$-C_{re}$	Reverse capacitance	I_C = -2 mA V_{CE} = -10 V f = 450 kHz		0.23		pF
NF*	Noise figure	I_C = -2 mA V_{CE} = -10 V R_g = 60 Ω f = 800 MHz		5	6	dB
G_{pb}*	Power gain	I_C = -2 mA V_{CE} = -10 V R_L = 2 kΩ f = 800 MHz	11	14		dB

* See test circuit.

Typical output characteristics

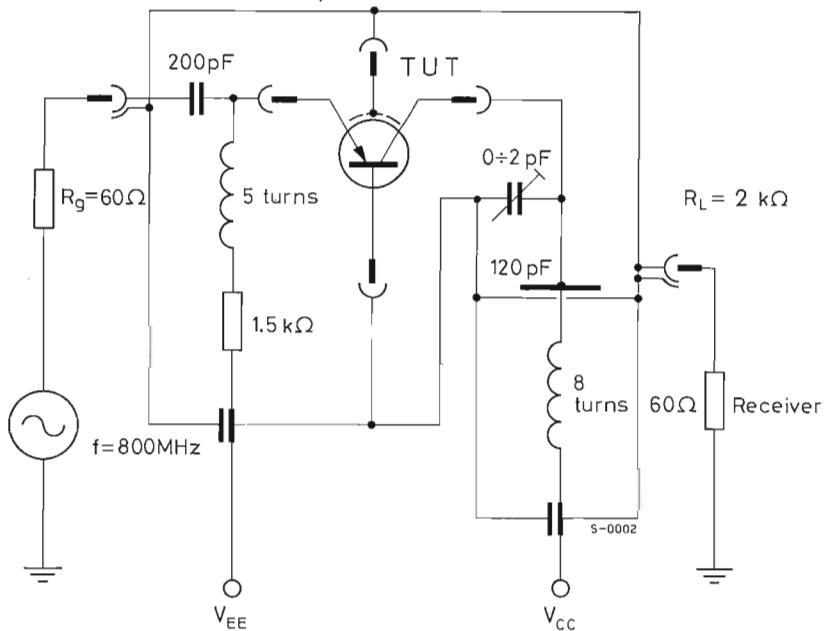
Typical output characteristics

Typical collector current

Typical DC transconductance

AF 239

Collector cutoff current

Transition frequency

Noise figure

Typical input admittance

Typical reverse admittance

Typical transfer admittance

Typical output admittance

Power gain

Power gain

Power gain

TEST CIRCUIT

800 MHz transducer power gain G_{pb} and noise figure test circuit

AF 239S

GERMANIUM MESA PNP

UHF PREAMPLIFIER

The AF 239S is a germanium mesa PNP transistor in a Jedec TO-72 metal case. It is particularly designed as preamplifier, mixer and oscillator up to 900 MHz.

ABSOLUTE MAXIMUM RATINGS

V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	-20	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-15	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-0.3	V
I_C	Collector current	-10	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 45\,°C$	60	mW
	at $T_{case} \leq 66\,°C$	60	mW
T_{stg}	Storage temperature	-30 to 75	°C
T_j	Junction temperature	90	°C

MECHANICAL DATA

Dimensions in mm

Shield lead connected to case

TO-72

6/68

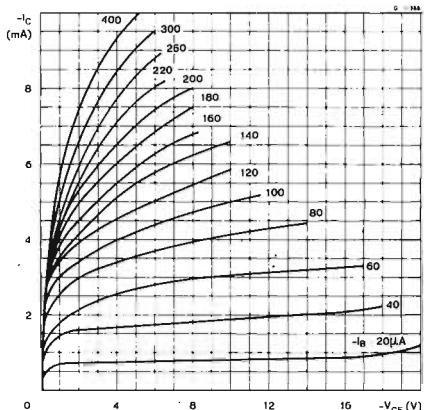
AF 239S

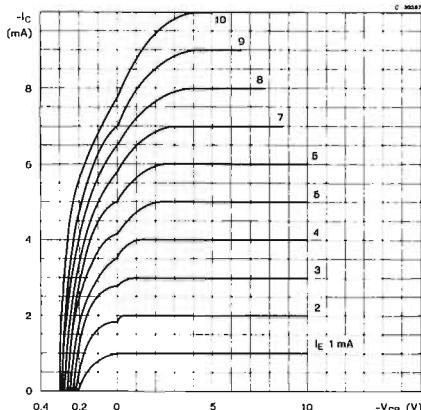
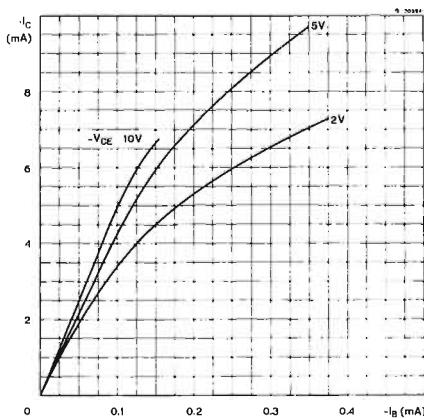
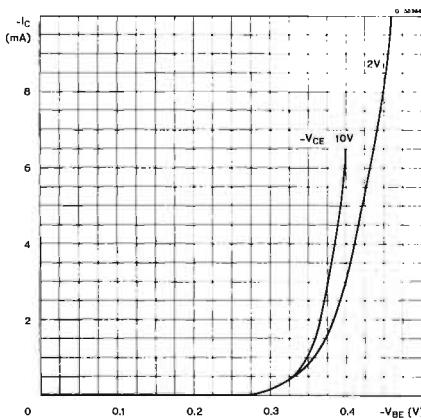
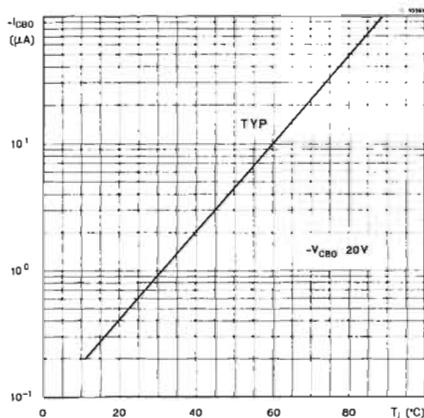
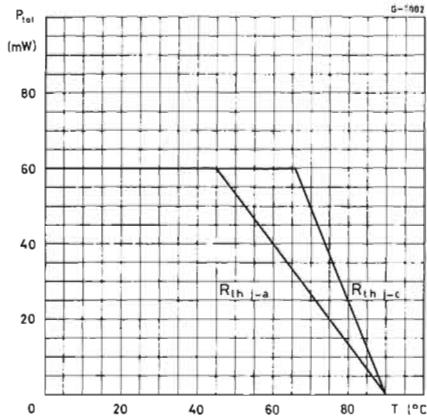
THERMAL DATA

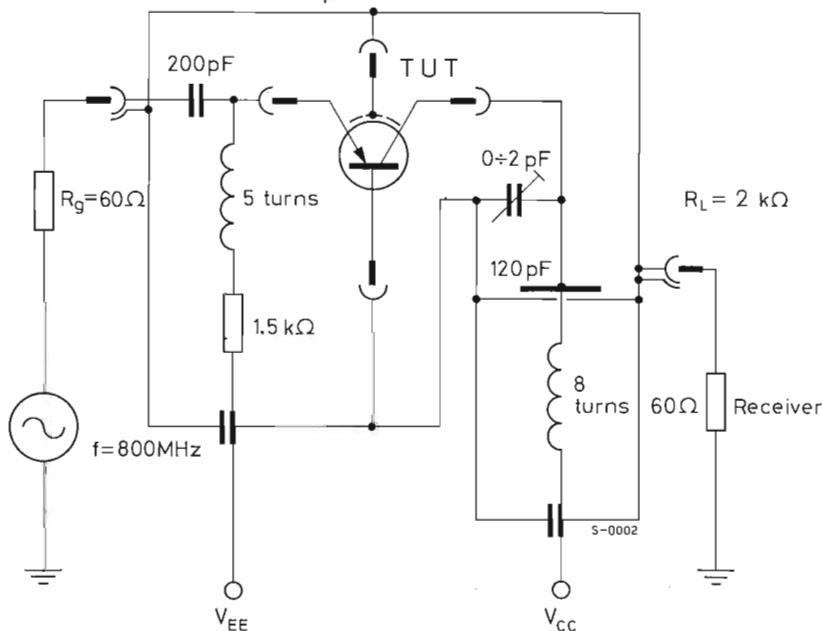
$R_{th\ j-case}$	Thermal resistance junction-case	max	400	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	750	°C/W

ELECTRICAL CHARACTERISTICS (T_{case} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = -20 V			-8	μA
I_{CEO}	Collector cutoff current (I_B = 0)	V_{CE} = -15 V			-500	μA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = -0.3 V			-100	μA
V_{BE}	Base-emitter voltage	I_C = -2 mA V_{CE} = -10 V I_C = -5 mA V_{CE} = -5 V		-350 -400		mV mV
h_{FE}	DC current gain	I_C = -2 mA V_{CE} = -10 V I_C = -5 mA V_{CE} = -10 V	10	 30		— —
f_T	Transition frequency	I_C = -2 mA V_{CE} = -10 V f = 100 MHz		780		MHz
$-C_{re}$	Reverse capacitance	I_C = -2 mA V_{CE} = -10 V f = 450 kHz		0.2		pF
NF*	Noise figure	I_C = -1 mA V_{CE} = -10 V R_g = 60 Ω f = 800 MHz			5	dB
G_{pb}*	Power gain	I_C = -2 mA V_{CE} = -10 V R_L = 2 kΩ R_g = 60 Ω f = 800 MHz	12.5	15		dB

* See test circuit

Typical output characteristics

Typical output characteristics

Typical collector current

Typical DC transconductance

Collector cutoff current

Power rating chart

TEST CIRCUIT

800 MHz transducer power gain G_{pb} and noise figure test circuit

SILICON TRANSISTORS

SILICON PLANAR NPN

BC 107
BC 108
BC 109

LOW NOISE GENERAL PURPOSE AUDIO AMPLIFIERS

The BC 107, BC 108 and BC 109 are silicon planar epitaxial NPN transistors in TO-18 metal case. They are suitable for use in driver stages, low noise input stages and signal processing circuits of television receivers.
The complementary PNP types are respectively the BC 177, BC 178 and BC 179.

ABSOLUTE MAXIMUM RATINGS

		BC 107	BC 108	BC 109
V_{CBO}	Collector-base voltage ($I_E = 0$)	50 V	30 V	30 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	45 V	20 V	20 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	6 V	5 V	5 V
I_C	Collector current		100 mA	
P_{tot}	Total power dissipation at $T_{amb} \leq 25$ °C		0.3 W	
	at $T_{case} \leq 25$ °C		0.75 W	
T_{stg}	Storage temperature		-55 to 175 °C	
T_j	Junction temperature		175 °C	

MECHANICAL DATA

Dimensions in mm

(sim. to **TO-18**)

BC 107
BC 108
BC 109

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	200	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	500	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	for **BC 107**				
		V_{CB} = 40 V			15	nA
		V_{CB} = 40 V T_{amb} = 150 °C			15	μA
		for **BC 108 - BC 109**				
		V_{CB} = 20 V			15	nA
		V_{CB} = 20 V T_{amb} = 150 °C			15	μA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	I_C = 10 μA				
		for **BC 107**	50			V
		for **BC 108**	30			V
		for **BC 109**	30			V
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage ($I_B = 0$)	I_C = 10 mA				
		for **BC 107**	45			V
		for **BC 108**	20			V
		for **BC 109**	20			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	I_E = 10 μA				
		for **BC 107**	6			V
		for **BC 108**	5			V
		for **BC 109**	5			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	I_C = 10 mA I_B = 0.5 mA		70	250	mV
		I_C = 100 mA I_B = 5 mA		200	600	mV
V_{BE}*	Base-emitter voltage	I_C = 2 mA V_{CE} = 5 V	550	650	700	mV
		I_C = 10 mA V_{CE} = 5 V		700	770	mV
$V_{BE(sat)}$*	Base-emitter saturation voltage	I_C = 10 mA I_B = 0.5 mA		750		mV
		I_C = 100 mA I_B = 5 mA		900		mV

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{FE}*	DC current gain	I_C = 2 mA V_{CE} = 5 V				
		for **BC 107**	110	230	450	—
		for **BC 107** Gr. A	110	180	220	—
		for **BC 107** Gr. B	200	290	450	—
		for **BC 108**	110	350	800	—
		for **BC 108** Gr. A	110	180	220	—
		for **BC 108** Gr. B	200	290	450	—
		for **BC 108** Gr. C	420	520	800	—
		for **BC 109**	200	350	800	—
		for **BC 109** Gr. B	200	290	450	—
		for **BC 109** Gr. C	420	520	800	—
		I_C = 10 µA V_{CE} = 5 V				
		for **BC 107**		120		—
		for **BC 107** Gr. A		90		—
		for **BC 107** Gr. B	40	150		—
		for **BC 108**		120		—
		for **BC 108** Gr. A		90		—
		for **BC 108** Gr. B	40	150		—
		for **BC 108** Gr. C	100	270		—
		for **BC 109**	70	210		—
		for **BC 109** Gr. B	40	150		—
		for **BC 109** Gr. C	100	270		—
h_{fe}	Small signal current gain	I_C = 2 mA V_{CE} = 5 V f = 1 kHz				
		for **BC 107**		250		—
		for **BC 107** Gr. A		190		—
		for **BC 107** Gr. B		300		—
		for **BC 108**		370		—
		for **BC 108** Gr. A		190		—
		for **BC 108** Gr. B		300		—
		for **BC 108** Gr. C		500		—
		for **BC 109**		370		—
		for **BC 109** Gr. B		300		—
		for **BC 109** Gr. C		550		—
		I_C = 10 mA V_{CE} = 10 V f = 100 MHz		2		—
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = 10 V f = 1 MHz		4	6	pF

* Pulsed: pulse duration = 300 µs, duty factor = 1%.

BC 107
BC 108
BC 109

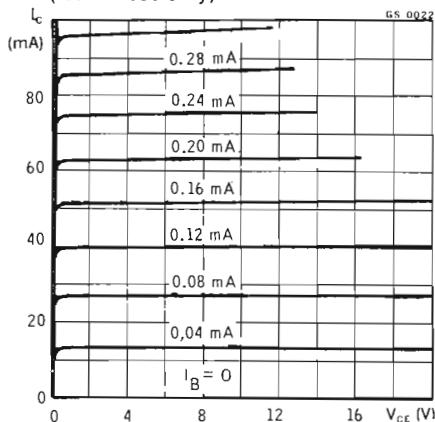
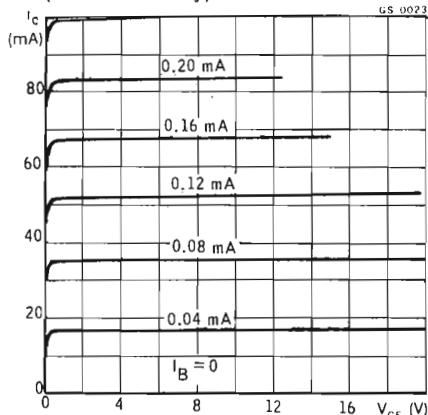
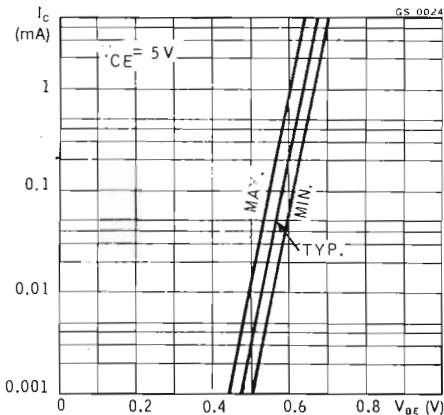
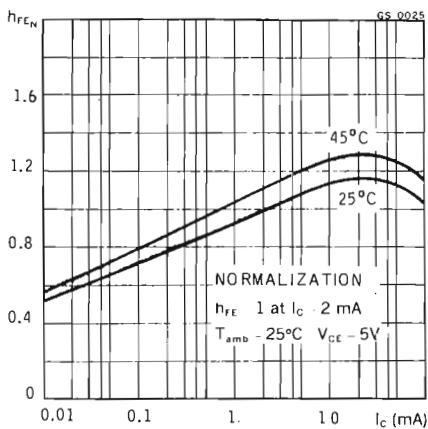
ELECTRICAL CHARACTERISTICS (continued)

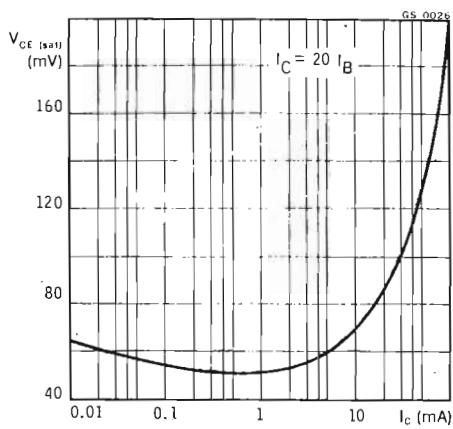
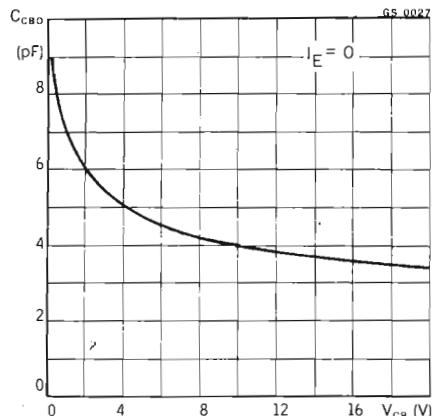
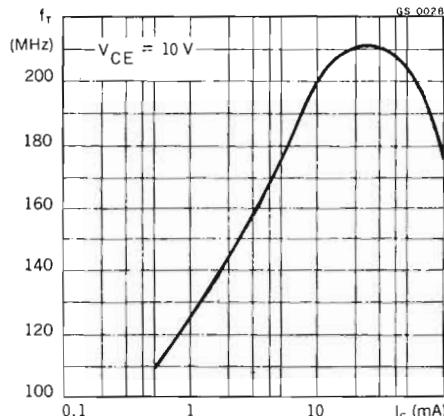
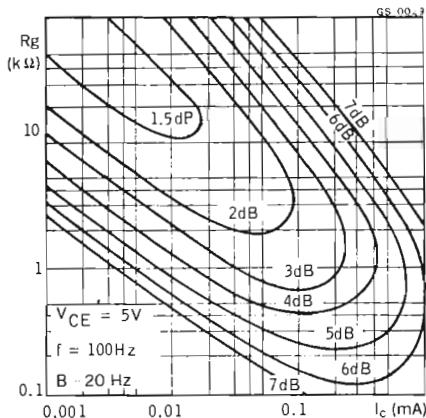
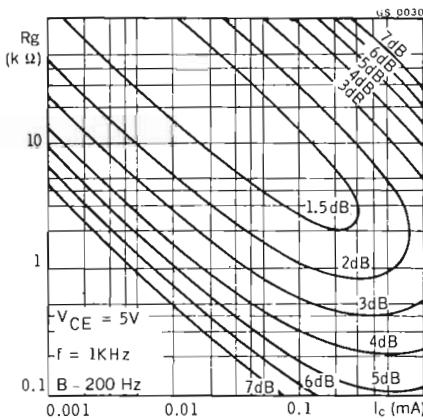
Parameter		Test conditions	Min.	Typ.	Max.	Unit
C_{EBO}	Emitter-base capacitance	I_C = 0 V_{EB} = 0.5 V f = 1 MHz		11.5		pF
NF	Noise figure	I_C = 0.2 mA V_{CE} = 5 V R_g = 2 kΩ f = 1 kHz B = 200 Hz				
		for **BC 107**		2	10	dB
		for **BC 108**		2	10	dB
		for **BC 109**		1.5	4	dB
		I_C = 0.2 mA V_{CE} = 5 V R_g = 2 kΩ f = 10 Hz to 10 kHz B = 15.7 kHz				
		for **BC 109**		1.5	4	dB
h_{ie}	Input impedance	I_C = 2 mA V_{CE} = 5 V f = 1 kHz				
		for **BC 107**		4		kΩ
		for **BC 107** Gr. A		3		kΩ
		for **BC 107** Gr. B		4.8		kΩ
		for **BC 108**		5.5		kΩ
		for **BC 108** Gr. A		3		kΩ
		for **BC 108** Gr. B		4.8		kΩ
		for **BC 108** Gr. C		7		kΩ
		for **BC 109**		5.5		kΩ
		for **BC 109** Gr. B		4.8		kΩ
		for **BC 109** Gr. C		7		kΩ
h_{re}	Reverse voltage ratio	I_C = 2 mA V_{CE} = 5 V f = 1 kHz				
		for **BC 107**		2.2×10^{-4}		—
		for **BC 107** Gr. A		1.7×10^{-4}		—
		for **BC 107** Gr. B		2.7×10^{-4}		—
		for **BC 108**		3.1×10^{-4}		—
		for **BC 108** Gr. A		1.7×10^{-4}		—
		for **BC 108** Gr. B		2.7×10^{-4}		—
		for **BC 108** Gr. C		3.8×10^{-4}		—
		for **BC 109**		3.1×10^{-4}		—
		for **BC 109** Gr. B		2.7×10^{-4}		—
		for **BC 109** Gr. C		3.8×10^{-4}		—

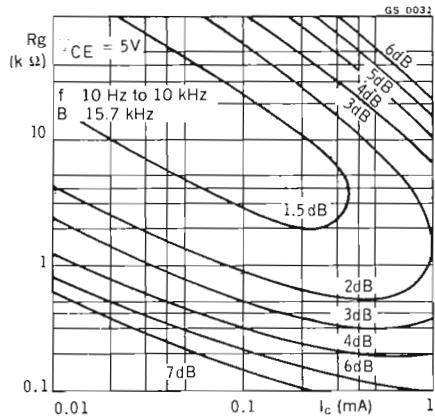
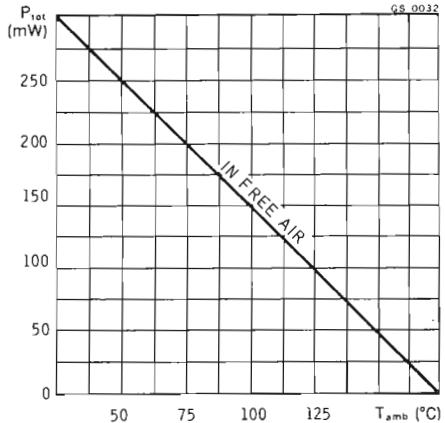
ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{oe}	Output admittance	I_C = 2 mA V_{CE} = 5 V f = 1 kHz				
		for **BC 107**		20		μS
		for **BC 107** Gr. A		13		μS
		for **BC 107** Gr. B		26		μS
		for **BC 108**		30		μS
		for **BC 108** Gr. A		13		μS
		for **BC 108** Gr. B		26		μS
		for **BC 108** Gr. C		34		μS
		for **BC 109**		30		μS
		for **BC 109** Gr. B		26		μS
		for **BC 109** Gr. C		34		μS

Typical output characteristics
(for **BC 107** only)

Typical output characteristics
(for **BC 108** only)

Typical output characteristics (for **BC 109** only)

DC transconductance

DC normalized current gain

Collector-emitter saturation voltage

Collector-base capacitance

Transition frequency

Noise figure (for **BC 109** only)

Noise figure (for **BC 109** only)

Noise figure (for **BC 109** only)

Power rating chart

SILICON PLANAR NPN

BC 113
BC 114

HIGH GAIN, LOW NOISE AUDIO AMPLIFIERS

The BC 113 and BC 114 are silicon planar NPN transistors in TO-18 epoxy package. They are specifically designed for use in low-noise audio preamplifiers.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	30	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	30	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	6	V
I_C	Collector current	50	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25\,°C$	200	mW
	at $T_{case} \leq 25\,°C$	500	mW
T_{stg}	Storage temperature	-55 to 125	°C
T_j	Junction temperature	125	°C

MECHANICAL DATA

Dimensions in mm

TO-18 epoxy

BC 113
BC 114

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	200	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	500	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

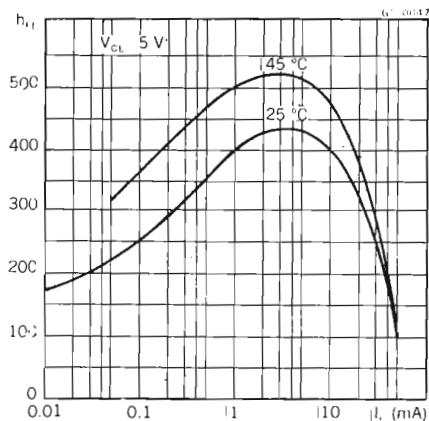
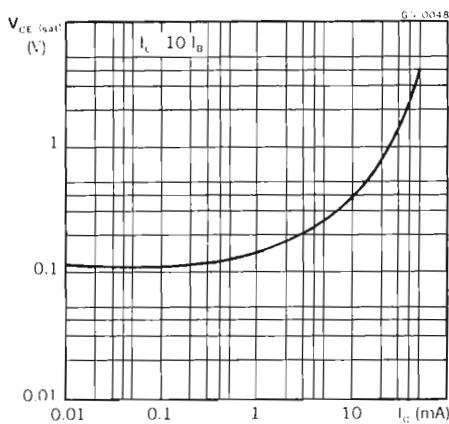
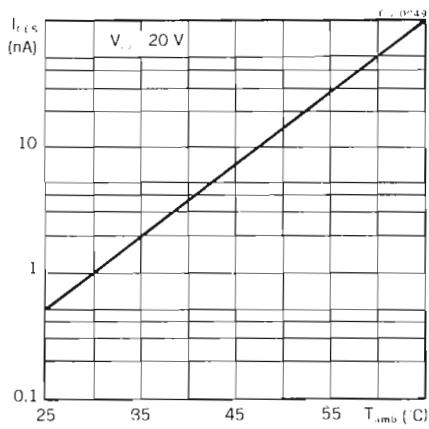
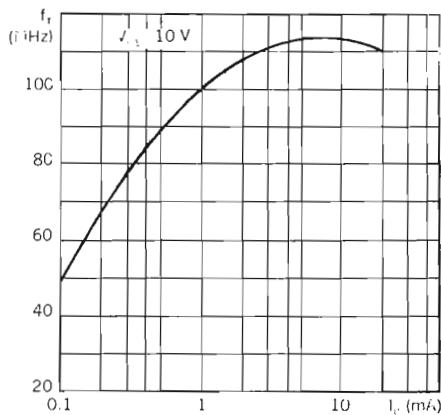
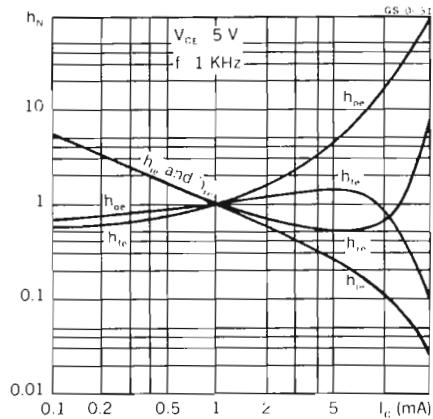
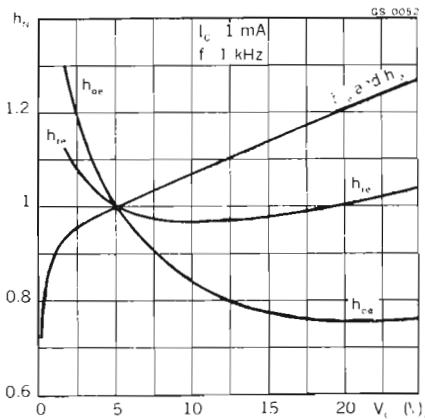
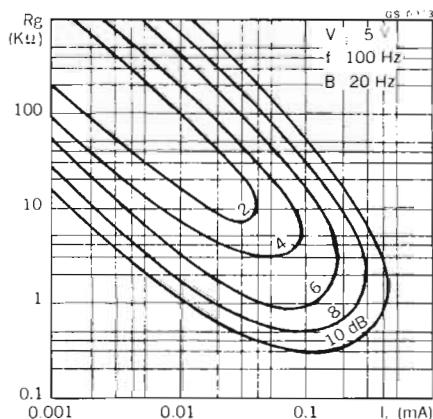
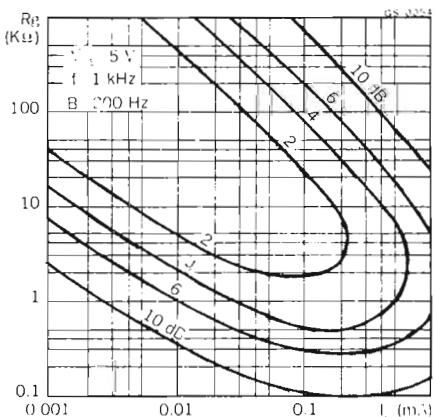
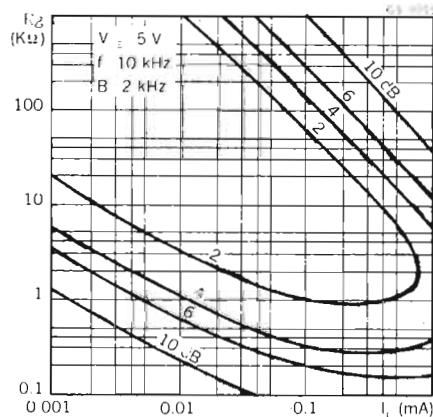
	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = 20 V			50	nA
		V_{CE} = 20 V T_{amb} = 65°C			5	µA
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage (I_B = 0)	I_C = 10 mA	30			V
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 10 µA	30			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = 10 µA	6			V
V_{BE}	Base-emitter voltage	I_C = 1 mA V_{CE} = 5 V		0.64	0.7	V
h_{FE}	DC current gain	I_C = 10 µA V_{CE} = 5 V		170		—
		I_C = 100 µA V_{CE} = 5 V	120	250		—
		I_C = 1 mA V_{CE} = 5 V	200		1000	—
		I_C = 10 mA V_{CE} = 5 V				
		for **BC 113**		400		—
		for **BC 114**	200	400		—
f_T	Transition frequency	I_C = 1 mA V_{CE} = 5 V				
		for **BC 113**	60	100		MHz
		for **BC 114**	70	100		MHz
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = 5 V		2.7	4	pF
NF	Noise figure	I_C = 10µA V_{CE} = 5 V				
		R_g = 10 kΩ f = 1 kHz				
		B = 200 Hz				
		for **BC 113**		2.5		dB
		for **BC 114**		1.5	3	dB

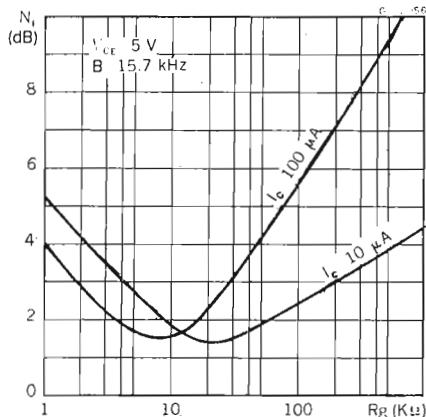
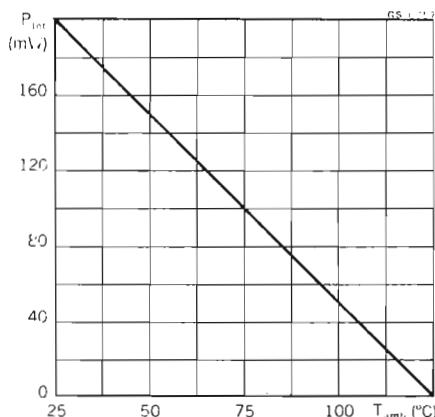
* Pulsed: pulse duration = 300 µs, duty factor = 1%.

Typical output characteristics

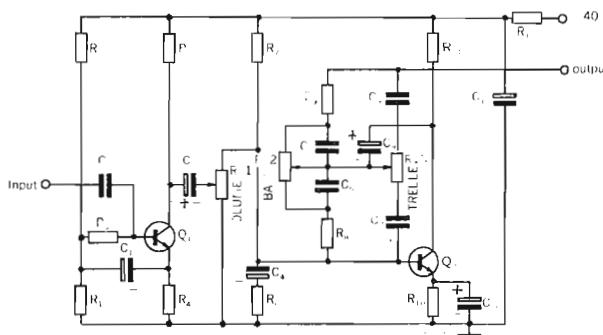
Typical output characteristics

DC transconductance

DC current gain

Collector-emitter saturation voltage

Collector cutoff current

Transition frequency

Typical normalized h parameters

Typical normalized h parameters

Noise figure (for **BC 114** only)

Noise figure (for **BC 114** only)

Noise figure (for **BC 114** only)

BC 113
BC 114

Noise figure (for **BC 114** only)

Power rating chart

TYPICAL APPLICATION

Audio preamplifier

R_1 = 470 kΩ
R_2 = 1.8 MΩ
R_3 = 18 kΩ
R_4 = 10 kΩ
R_5 = 33 kΩ
R_6 = 82 kΩ
R_7 = 270 kΩ
R_8 = 22 kΩ
R_9 = 2.2 kΩ
R_{10} = 8.2 kΩ
R_{11} = 22 kΩ
R_{12} = 27 kΩ
C_1 = 1 μF 5 V
C_2 = 0.2 μF 12 V
C_3 = 5 μF 15 V
C_4 = 5 μF 5 V
C_5 = 0.015 μF
C_6 = 0.15 μF
C_7 = 0.0039 μF
C_8 = 0.039 μF
C_9 = 5 μF 10 V
C_{10} = 100 μF 5 V
C_{11} = 100 μF 50 V
RV_1 = 25 kΩ Linear
RV_2 = 100 kΩ Anti-log
RV_3 = 50 kΩ Anti-log
Q_1 = BC 114
Q_2 = BC 113

Overall performance

Sensitivity	< 150 mV for 100 μA, output into 200Ω load
Input impedance	> 1.5 MΩ
Signal/noise ratio	> 75 dB
Maximum input voltage	2 V
Bass boost	+ 10 dB (60 Hz)
Bass cut	- 15 dB (60 Hz)
Treble boost	+ 10 dB (12 kHz)
Treble cut	- 13 dB (12 kHz)

SILICON PLANAR NPN

BC 115

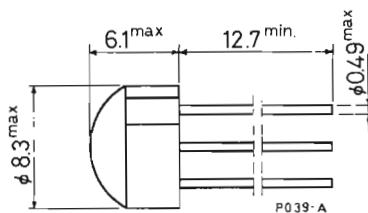
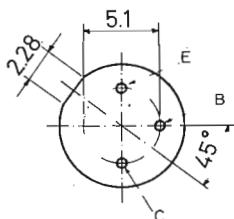
AUDIO DRIVER

The BC 115 is a silicon planar epitaxial NPN transistor in a TO-39 epoxy package. It is particularly suited for use in audio driver circuits.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	40	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	30	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	5	V
I_C	Collector current	200	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25\ °C$	0.3	W
	at $T_{case} \leq 25\ °C$	0.8	W
T_{stg}	Storage temperature	-55 to 125	°C
T_j	Junction temperature	125	°C

MECHANICAL DATA

Dimensions in mm

TO-39 epoxy

BC 115

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	125	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	330	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)	V_{CB} = 20 V V_{CB} = 20 V T_{amb} = 65°C			100 5	nA μA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 100 μA	40			V
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage (I_B = 0)	I_C = 30 mA	30			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_C = 10 μA	5			V
$V_{CE\ (sat)}$*	Collector-emitter saturation voltage	I_C = 100 mA I_B = 10 mA		0.4	1	V
V_{BE}	Base-emitter voltage	I_C = 10 mA V_{CE} = 10 V I_C = 100 mA V_{CE} = 10 V		0.65 0.75		V V
$V_{BE\ (sat)}$*	Base-emitter saturation voltage	I_C = 100 mA I_B = 10 mA		0.8	0.9	V
h_{FE}*	DC current gain	I_C = 100 μA V_{CE} = 10 V I_C = 1 mA V_{CE} = 10 V I_C = 10 mA V_{CE} = 10 V I_C = 100 mA V_{CE} = 10 V	 50 100 50	95 145 170 150	 400 	— — — —
f_T	Transition frequency	I_C = 10 mA V_{CE} = 10 V		80		MHz

* Pulsed: pulse duration = 300 μs, duty factor = 1%.

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = 10$ V $f = 1$ MHz		12	25	pF
h_{ie}	Input impedance	$I_C = 10$ mA $V_{CE} = 10$ V $f = 1$ kHz		550		Ω
h_{re}	Voltage feedback ratio	$I_C = 10$ mA $V_{CE} = 10$ V $f = 1$ kHz		0.9×10^{-4}		—
h_{oe}	Output admittance	$I_C = 10$ mA $V_{CE} = 10$ V $f = 1$ kHz		50		μS

SILICON PLANAR PNP

BC 116A

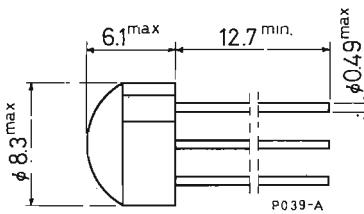
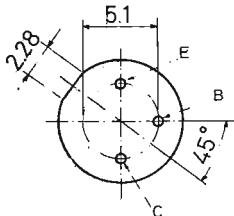
GENERAL PURPOSE TRANSISTOR

The BC 116A is a silicon planar epitaxial PNP transistor in a TO-39 epoxy package. It is designed as general purpose device for application over a wide range of collector current.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-45	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-40	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-5	V
I_C	Collector current	-500	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25\ °C$	0.3	W
	at $T_{case} \leq 25\ °C$	0.8	W

MECHANICAL DATA

Dimensions in mm

TO-39 epoxy

BC 116A

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	125	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	330	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	V_{CB} = -20 V			-100	nA
		V_{CB} = -20 V T_{amb} = 75 °C			-10	μA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage ($I_E = 0$)	I_C = -10 μA	-45			V
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage ($I_B = 0$)	I_C = -10 mA	-40			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	I_C = -10 μA	-5			V
$V_{CE\ (sat)}$*	Collector-emitter saturation voltage	I_C = -50 mA I_B = -5 mA			-0.25	V
		I_C = -150 mA I_B = -15 mA			-0.40	V
V_{BE}*	Base-emitter voltage	I_C = -10 mA V_{CE} = -10 V		-0.70		V
		I_C = -50 mA V_{CE} = -1 V		-0.75	-1	V
$V_{BE\ (sat)}$*	Base-emitter saturation voltage	I_C = -50 mA I_B = -5 mA		-0.80		V
		I_C = -150 mA I_B = -15 mA		-1	-1.3	V
h_{FE}	DC current gain	I_C = -100 μA V_{CE} = -10 V	30	90		—
		I_C = -10 mA V_{CE} = -1 V	60	150		—
		I_C = -50 mA V_{CE} = -1 V	60	150		—
		I_C = -150 mA V_{CE} = -10 V	80	150	240	—
f_T	Transition frequency	I_C = -30 mA V_{CE} = -10 V	130	200		MHz
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = -10 V, f = 1 MHz		5	10	pF

* Pulsed: pulse duration = 300 μs, duty factor = 1%.

BC 119

SILICON PLANAR NPN

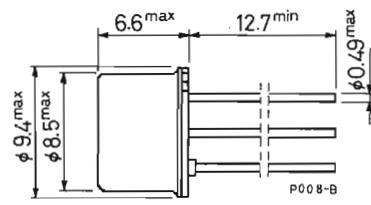
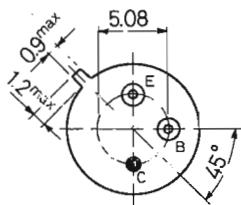
AUDIO OUTPUT AMPLIFIER

The BC 119 is a silicon planar epitaxial NPN transistor in a TO-39 metal case. It is suitable for 1 W class "A" and up to 6 W class "B" audio output stages and is available as a pair 2. BC 119.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	60	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	30	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	5	V
P_{tot}	Total power dissipation at $T_{amb} \leq 25\,°C$	0.8	W
	at $T_{case} \leq 25\,°C$	5	W
	at $T_{case} \leq 100\,°C$	2.8	W
T_{stg}	Storage temperature	-55 to 200	°C
T_j	Junction temperature	200	°C

MECHANICAL DATA

Dimensions in mm

(sim. to **TO-39**)

BC 119

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	35	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	220	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	V_{CB} = 40 V			100	nA
		V_{CB} = 40 V T_{amb} = 150 °C			20	µA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage ($I_E = 0$)	I_C = 100 µA	60			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage ($I_B = 0$)	I_C = 30 mA	30			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	I_E = 100 µA	5			V
$V_{CE\ (sat)}$*	Collector-emitter saturation voltage	I_C = 150 mA I_B = 15 mA		0.15	0.35	V
		I_C = 500 mA I_B = 50 mA		0.4	1.1	V
		I_C = 1 A I_B = 100 mA		0.8	1.5	V
V_{BE}*	Base-emitter voltage	I_C = 500 mA V_{CE} = 10 V		1	1.8	V
		I_C = 150 mA V_{CE} = 1 V		0.85	1	V
$V_{BE\ (sat)}$*	Base-emitter saturation voltage	I_C = 150 mA I_B = 15 mA		0.9	1.2	V
		I_C = 1 A I_B = 0.1 A		1.4	2	V
h_{FE}*	DC current gain	I_C = 50 mA V_{CE} = 1 V	40	100		—
		I_C = 150 mA V_{CE} = 1 V	40	90	120	—
		I_C = 500 mA V_{CE} = 10 V	25	60		—
h_{FE_1}/h_{FE_2}	Matched pair	I_C = 300 mA V_{CE} = 5 V			1.4	—
f_T	Transition frequency	I_C = 50 mA V_{CE} = 10 V	40			MHz
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = 10 V		12	25	pF

* Pulsed: pulse duration = 300 µs, duty factor = 1%.

BC 125
BC 125B

SILICON PLANAR NPN

AUDIO DRIVERS

The BC 125 and BC 125 B are silicon planar epitaxial NPN transistors in TO-39 epoxy package. They are designed for use as audio drivers.

ABSOLUTE MAXIMUM RATINGS

		BC 125	BC 125 B
V_{CBO}	Collector-base voltage ($I_E = 0$)	50 V	60 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	5 V	6 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	30 V	
I_C	Collector current	0.5 A	
P_{tot}	Total power dissipation at $T_{amb} \leq 25\ °C$	0.3 W	
	at $T_{case} \leq 25\ °C$	0.8 W	
T_{stg}	Storage temperature	-55 to 125 °C	
T_j	Junction temperature	125 °C	

MECHANICAL DATA

Dimensions in mm

TO-39 epoxy

BC 125
BC 125B

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	125	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	330	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	for **BC 125**					
		V_{CB} = 20 V			0.5	100	nA
		V_{CB} = 20 V	T_{amb} = 75°C			20	μA
		for **BC 125 B**					
		V_{CB} = 40 V			0.5	100	nA
		V_{CB} = 40 V	T_{amb} = 75°C			20	μA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage ($I_E = 0$)	I_C = 10 μA					
			for **BC 125**	50			V
			for **BC 125 B**	60			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage ($I_B = 0$)	I_C = 30 mA		30			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	I_C = 10 μA					
			for **BC 125**	5			V
			for **BC 125 B**	6			V
$V_{CE\ (sat)}$*	Collector-emitter saturation voltage	for **BC 125**					
		I_C = 150 mA					
		I_B = 15 mA			0.2	2.5	V
		for **BC 125 B**					
		I_C = 150 mA					
		I_B = 15 mA			0.15	0.25	V
		I_C = 500 mA					
		I_B = 50 mA			0.4	0.8	V

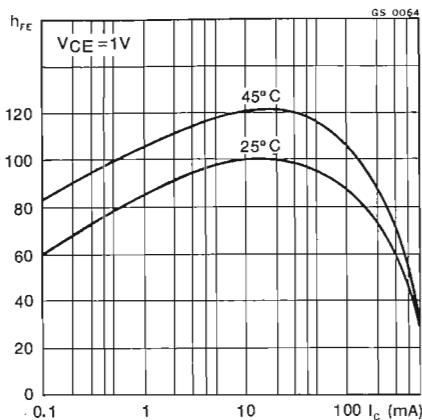
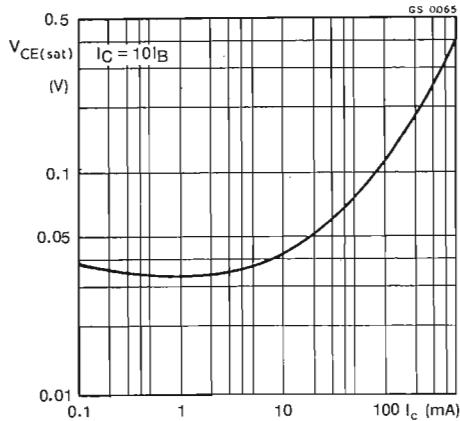
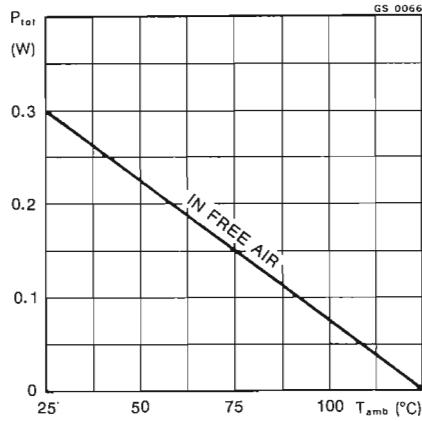
* Pulsed: pulse duration = 300 μs, duty factor = 1%.

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
V_{BE}*	Base-emitter voltage	I_C = 50 mA V_{CE} = 1 V		0.72		V
$V_{BE(sat)}$*	Base-emitter saturation voltage	for **BC 125**				
		I_C = 150 mA				
		I_B = 15 mA		1	1.3	V
		for **BC 125 B**				
		I_C = 150 mA				
		I_B = 15 mA		0.87	1	V
		I_C = 500 mA				
		I_B = 50 mA		1.1	1.3	V
h_{FE}*	DC current gain	for **BC 125**				
		I_C = 1 mA V_{CE} = 1V		50		—
		I_C = 10 mA V_{CE} = 1V		70		—
		I_C = 50 mA V_{CE} = 1V	30	75		—
		I_C = 150 mA V_{CE} = 1V	30	60		—
		I_C = 1 mA V_{CE} = 10 V	25	55		—
		I_C = 10 mA V_{CE} = 10 V	30	75		—
		for **BC 125 B**				
		I_C = 1 mA V_{CE} = 1V		85		—
		I_C = 10 mA V_{CE} = 1V	45	100		—
		I_C = 50 mA V_{CE} = 1V		95		—
		I_C = 150 mA V_{CE} = 1V	40	80	120	—
		I_C = 500 mA V_{CE} = 10 V		70		—
f_T	Transition frequency	I_C = 50 mA V_{CE} = 10 V	200	350		MHz
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = 10 V				
		f = 1 MHz				
		for **BC 125**		6	12	pF
		for **BC 125 B**		5	8	pF

* Pulsed: pulse duration = 300 µs, duty factor = 1%.

Typical output characteristics (for **BC 125 B** only)

DC current gain (for **BC 125 B** only)

Collector-emitter saturation voltage

Power rating chart

SILICON PLANAR PNP

BC 126

AUDIO DRIVER

The BC 126 is a silicon planar epitaxial PNP transistor in a TO-39 epoxy package. It is designed for audio driver applications. The complementary NPN type is the BC 125.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-35	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-30	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-5	V
I_C	Collector current	-0.5	A
P_{tot}	Total power dissipation at $T_{amb} \leq 25\ °C$	0.3	W
	at $T_{case} \leq 25\ °C$	0.8	W
T_{stg}	Storage temperature	-55 to 125	°C
T_j	Junction temperature	125	°C

MECHANICAL DATA

Dimensions in mm

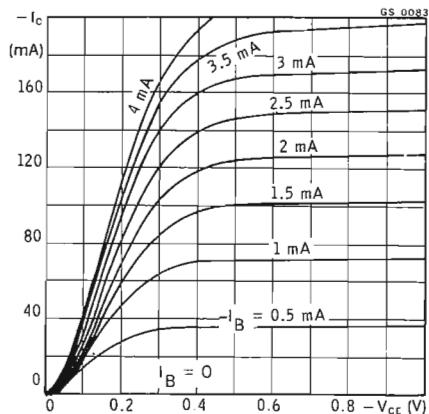
TO-39 epoxy

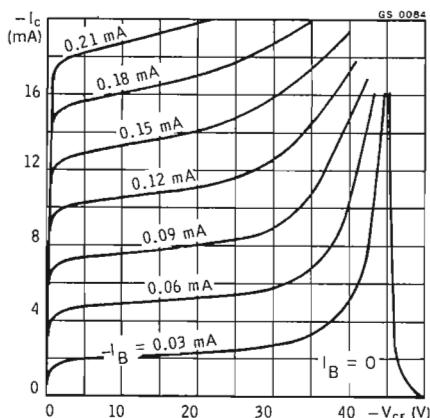
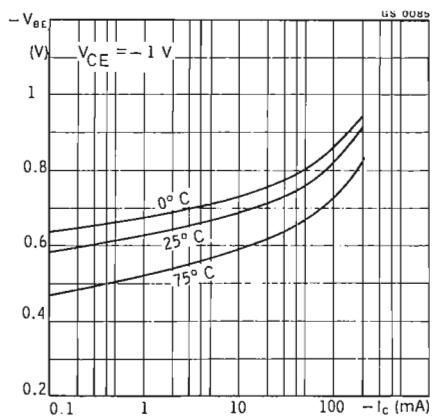
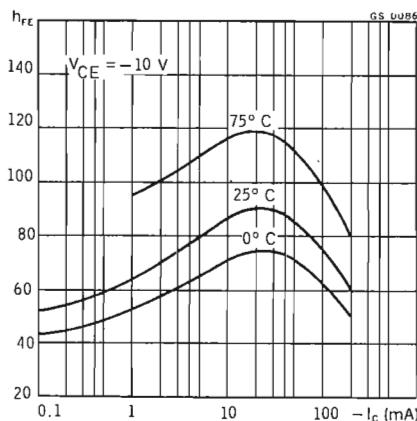
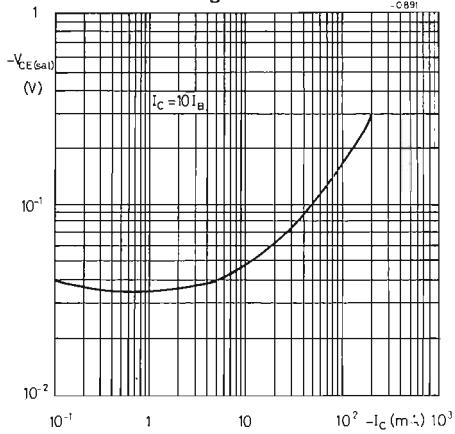
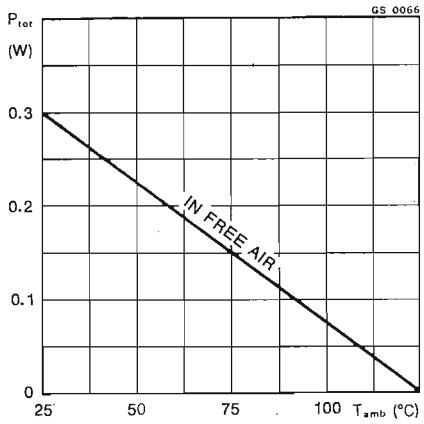
BC 126

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	125	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	330	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	V_{CB} = -20 V V_{CB} = -20 V T_{amb} = 75 °C			-100 -20	nA μA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage ($I_E = 0$)	I_C = -10 μA	-35			V
$V_{(BR)\ CEO}$	Collector-emitter breakdown voltage ($I_B = 0$)	I_C = -10 mA	-30			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	I_E = -10 μA	-5			V
$V_{CE\ (sat)}$	Collector-emitter saturation voltage	I_C = -50 mA I_B = -5 mA I_C = -150 mA I_B = -15 mA			-0.25 -0.50	V V
V_{BE}	Base-emitter voltage	I_C = -50 mA V_{CE} = -1 V		-0.75	-1	V
$V_{BE\ (sat)}$	Base-emitter saturation voltage	I_C = -150 mA I_B = -15 mA I_C = -50 mA I_B = -5 mA		-1 -0.8	-1.3	V V
h_{FE}	DC current gain	I_C = -50 mA V_{CE} = -1 V I_C = -150 mA V_{CE} = -1 V	30 30	80 60	 120	— —
f_T	Transition frequency	I_C = -50 mA V_{CE} = -20 V		200		MHz
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = -10 V f = 1 MHz		5		pF

Typical output characteristics

Typical output characteristics

Typical DC transconductance

Typical DC current gain

Typical collector emitter saturation voltage

Power rating chart

BC 132

SILICON PLANAR NPN

AUDIO AMPLIFIER

The BC 132 is a silicon planar NPN transistor in a TO-18 epoxy package. It is suitable for low level audio stages and direct coupled circuits.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	30	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	25	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	6	V
I_C	Collector current	20	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25\,°C$	0.2	W
	at $T_{case} \leq 25\,°C$	0.5	W
T_{stg}	Storage temperature	-55 to 125	°C
T_j	Junction temperature	125	°C

MECHANICAL DATA

Dimensions in mm

TO-18 epoxy

BC 132

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	200	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	500	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	$V_{CB} = 5$ V			100	nA
		$V_{CB} = 5$ V $T_{amb} = 65$°C			3	μA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage ($I_E = 0$)	$I_C = 100$ μA	30			V
$V_{(BR)\ CEO}$	Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = 10$ mA	25			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 100$ μA	6			V
$V_{CE\ (sat)}$	Collector-emitter saturation voltage	$I_C = 1$ mA, $I_B = 0.1$ mA			0.35	V
h_{FE}	DC current gain	$I_C = 50$ μA $V_{CE} = 10$ V		50		—
		$I_C = 1$ mA $V_{CE} = 10$ V	60		300	—
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = 5$ V		2.2	4	pF

BC 139

SILICON PLANAR PNP

AUDIO OUTPUT AMPLIFIER

The BC 139 is a silicon planar epitaxial PNP transistor in a TO-39 metal case. It is particularly designed for use in audio output and driver stages. The complementary NPN type is the BC 119.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-40	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-40	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-5	V
I_C	Collector current	-0.5	A
P_{tot}	Total power dissipation at $T_{amb} \leq 25\,°C$	0.7	W
	at $T_{case} \leq 25\,°C$	3	W
T_{stg}	Storage temperature	-55 to 200	°C
T_j	Junction temperature	200	°C

MECHANICAL DATA

Dimensions in mm

(sim. to **TO-39**)

5/73

BC 139

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	58	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	250	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

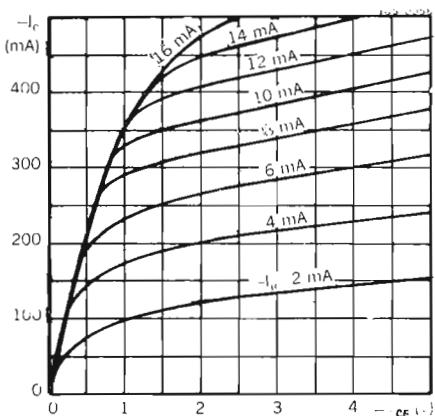
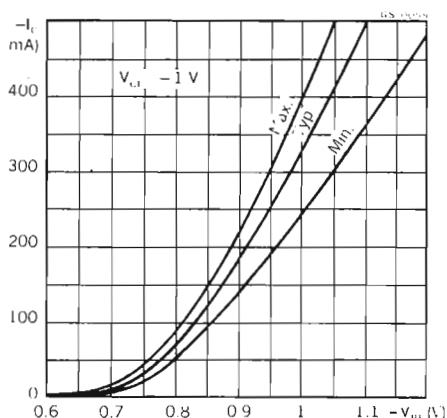
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	$V_{CB} = -30$ V			-100	nA
		$V_{CB} = -30$ V $T_{amb} = 75$°C			-50	µA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage ($I_E = 0$)	$I_C = -10$ µA	-40			V
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = -10$ mA	-40			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	$I_E = -10$ µA	-5			V
$V_{CE\ (sat)}$	Collector-emitter saturation voltage	$I_C = -300$ mA, $I_B = -30$ mA		-0.45	-0.8	V
		$I_C = -500$ mA, $I_B = -50$ mA		-1		V
V_{BE}	Base-emitter voltage	$I_C = -10$ mA, $V_{CE} = -10$ V		-0.7		V
		$I_C = -100$ mA, $V_{CE} = -10$ V		-0.77		V
		$I_C = -300$ mA, $V_{CE} = -1$ V		-0.97		V

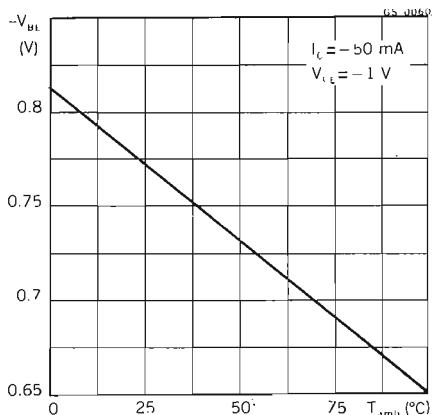
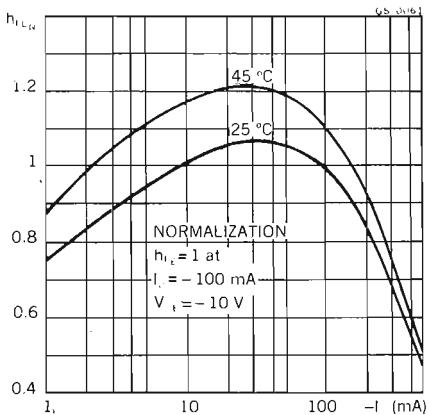
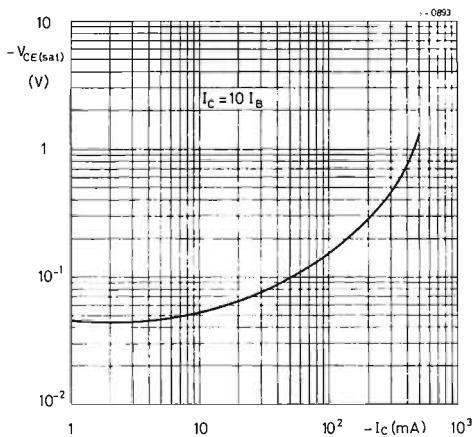
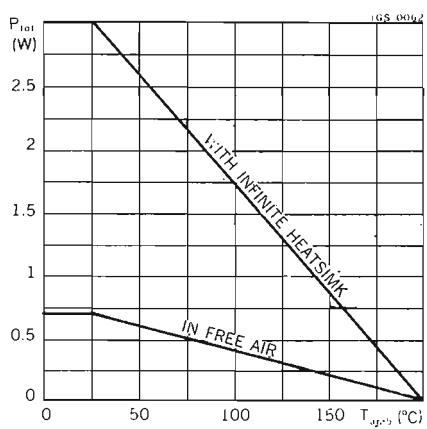
* Pulsed: pulse duration = 300 µs, duty factor = 1%.

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{FE}*	DC current gain	I_C = -10 mA V_{CE} = -10 V		90		—
		I_C = -100 mA V_{CE} = -10 V	40	90		—
		I_C = -150 mA V_{CE} = -1 V		45		—
		I_C = -300 mA V_{CE} = -1 V	20	35		—
f_T	Transition frequency	I_C = -50 mA V_{CE} = -10 V		200		MHz
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = -10 V f = 1 MHz		6		pF

* Pulsed: pulse duration = 300 µs, duty factor = 1%.

Typical output characteristics

DC transconductance

BC 139

Base-emitter voltage

DC normalized current gain

Collector-emitter saturation voltage

Power rating chart

SILICON PLANAR NPN

BC 140 BC 141

GENERAL PURPOSE TRANSISTORS

The BC 140 and BC 141 are silicon planar epitaxial NPN transistors in TO-39 metal case. They are particularly designed for audio amplifiers and switching applications up to 1 A.

The complementary PNP types are the BC 160 and BC 161.

ABSOLUTE MAXIMUM RATINGS

		BC 140	BC 141
V_{CBO}	Collector-base voltage ($I_E = 0$)	60 V	80 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	40 V	60 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	7 V	
I_C	Collector current	1 A	
I_B	Base current	0.1 A	
P_{tot}	Total power dissipation at $T_{amb} \leq 25$ °C	0.8 W	
	at $T_{case} \leq 25$ °C	4 W	
T_{stg}	Storage temperature	-55 to 200 °C	
T_j	Junction temperature	200 °C	

MECHANICAL DATA

Dimensions in mm

(sim. to **TO-39**)

BC 140
BC 141

THERMAL DATA

$R_{th\ j-case}$	Thermal resistence junction-case	max	44	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	220	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	V_{CB} = 50 V			200	nA
		V_{CB} = 50 V T_{amb} = 150°C			200	µA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage ($I_E = 0$)	I_C = 100 µA for **BC 140**	60			V
		for **BC 141**	80			V
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage ($I_B = 0$)	I_C = 10 mA for **BC 140**	40			V
		for **BC 141**	60			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	I_E = 100 µA	7			V
$V_{CE\ (sat)}$*	Collector-emitter saturation voltage	I_C = 100 mA I_B = 10 mA		0.1		V
		I_C = 500 mA I_B = 50 mA		0.35		V
		I_C = 1 A I_B = 0.1 A		0.6	1	V
V_{BE}*	Base-emitter voltage	I_C = 1 A V_{CE} = 1 V		1.25	1.6	V

* Pulsed: pulse duration = 300 µs, duty factor = 1%.

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{FE}*	DC current gain	I_C = 100 µA V_{CE} = 1 V				
		for **BC 140-141**		75		—
		for **BC 140-141** Gr. 6		28		—
		for **BC 140-141** Gr. 10		40		—
		I_C = 100 mA V_{CE} = 1 V				
		for **BC 140-141**	40	140	250	—
		for **BC 140-141** Gr. 6	40	63	100	—
		for **BC 140-141** Gr. 10	63	100	160	—
		I_C = 1 A V_{CE} = 1 V				
		for **BC 140-141**		26		—
		for **BC 140-141** Gr. 6		15		—
		for **BC 140-141** Gr. 10		20		—
h_{FE_1}/h_{FE_2}	Matched pair ratio	I_C = 100 mA V_{CE} = 1 V			1.25	—
f_T	Transition frequency	I_C = 50 mA V_{CE} = 10 V	50			MHz
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = 20 V f = 1 MHz		12		pF
t_{on}	Turn-on time	I_C = 100 mA I_{B1} = 5 mA			250	ns
t_{off}	Turn-off time	I_C = 100 mA I_{B1} = I_{B2} = 5 mA			850	ns

* Pulsed: pulse duration = 300 µs, duty factor = 1%.

SILICON PLANAR PNP

BC 153
BC 154

LOW-NOISE AUDIO AMPLIFIERS

The BC 153 and BC 154 are silicon planar epitaxial PNP transistors in TO-18 epoxy package. They are specifically designed for use in low-noise audio preamplifiers.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-40	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-40	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-5	V
I_C	Collector current	-100	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25\ °C$	0.2	W
	at $T_{case} \leq 25\ °C$	0.5	W
T_{stg}	Storage temperature	-55 to 125	°C
T_j	Junction temperature	125	°C

MECHANICAL DATA

Dimensions in mm

TO-18 epoxy

BC 153
BC 154

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	200	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	500	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

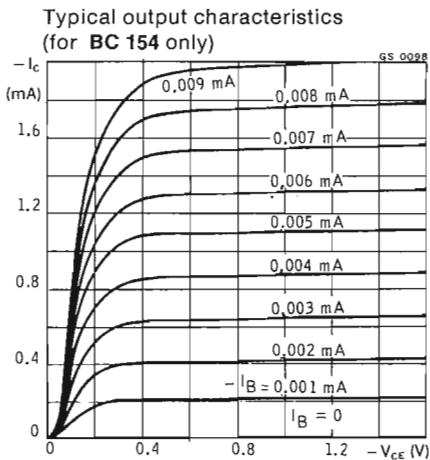
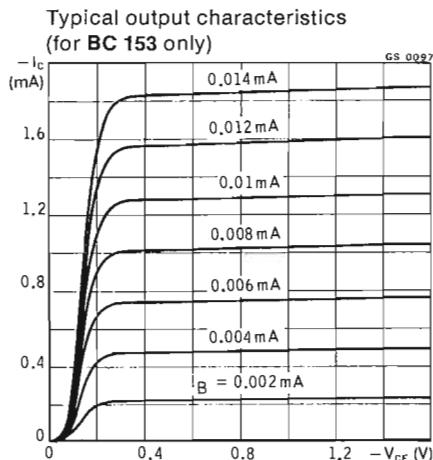
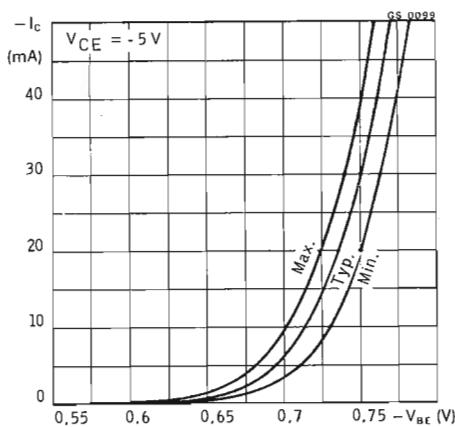
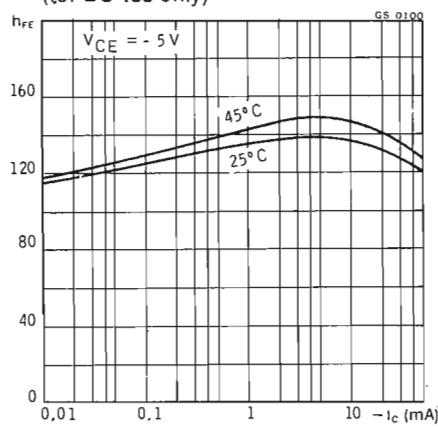
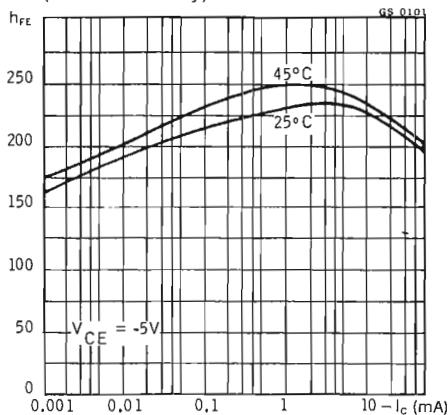
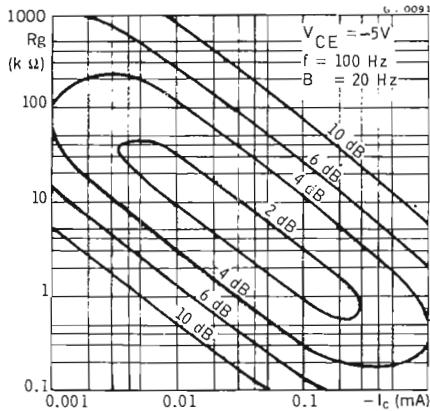
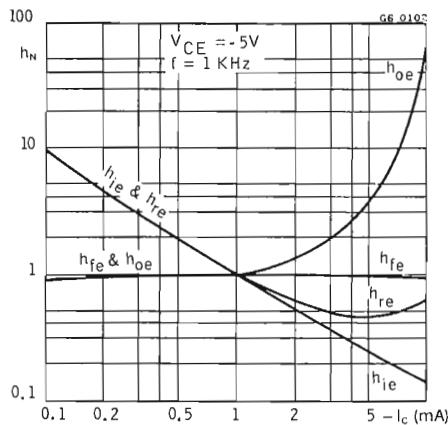
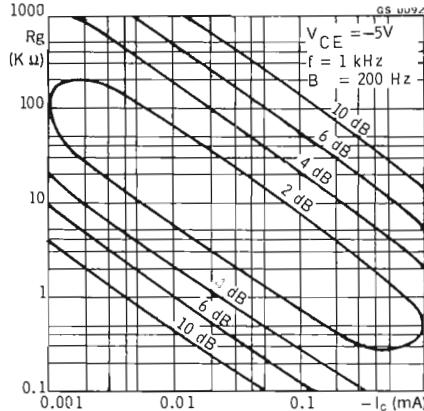
Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	$V_{CB} = -30$ V				-50	nA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage ($I_E = 0$)	$I_C = -10$ μA		-40			V
$V_{(BR)\ CEO}$	Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = -5$ mA		-40			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	$I_E = -10$ μA		-5			V
$V_{CE\ (sat)}$	Collector-emitter saturation voltage	$I_C = -10$ mA $I_B = -0.5$ mA				-0.25	V
h_{FE}	DC current gain	$I_C = -10$ μA	$V_{CE} = -5$ V				
			for **BC 153**		115		—
			for **BC 154**		190		—
		$I_C = -100$ μA	$V_{CE} = -5$ V				
			for **BC 153**	50	125		—
			for **BC 154**	160	215		—
		$I_C = -1$ mA	$V_{CE} = -5$ V				
			for **BC 153**	50	135		—
			for **BC 154**	160	230		—
		$I_C = -10$ mA	$V_{CE} = -5$ V				
			for **BC 153**	50	135		—
			for **BC 154**	160	225		—
f_T	Transition frequency	$I_C = -1$ mA	$V_{CE} = -5$ V		70		MHz
C_{CBO}	Collector-base capacitance	$I_E = 0$ $f = 1$ MHz	$V_{CB} = -5$ V		4		pF

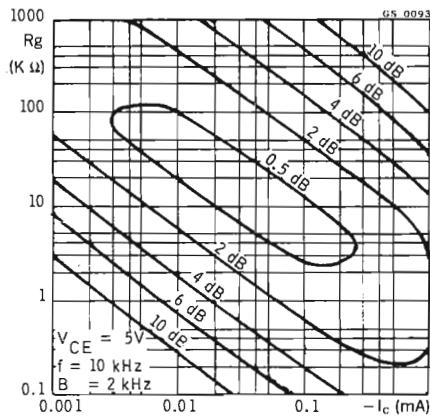
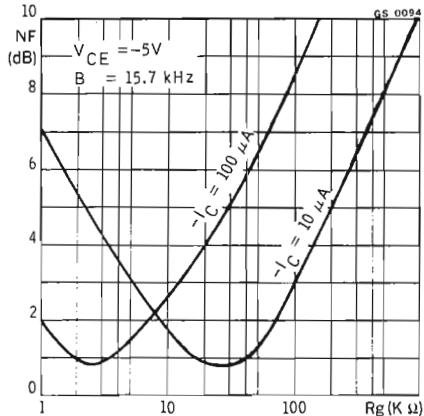
ELECTRICAL CHARACTERISTICS (continued)

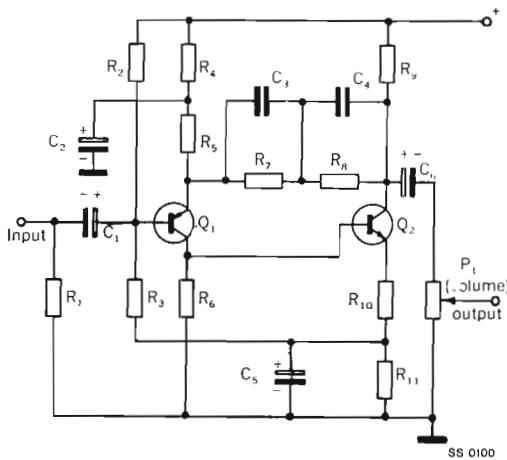
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
NF	Noise figure	I_C = -20 μA V_{CE} = -5 V R_g = 10 kΩ f = 1 kHz B = 200 Hz				
		for **BC 153**		1		dB
		for **BC 154**		0.75	2.5	dB
		I_C = -250 μA V_{CE} = -5 V R_g = 1 kΩ f = 1 kHz B = 200 Hz				
		for **BC 153**		1		dB
		for **BC 154**		0.75	2.5	dB
h_{ie}	Input impedance	I_C = -1 mA V_{CE} = -5 V f = 1 kHz				
		for **BC 153**		5.2		kΩ
		for **BC 154**		7.1		kΩ
h_{re}	Reverse voltage ratio	I_C = -1 mA V_{CE} = -5 V f = 1 kHz				
		for **BC 153**		1.8×10^{-4}		—
		for **BC 154**		2.9×10^{-4}		—
h_{oe}	Output admittance	I_C = -1 mA V_{CE} = -5 V f = 1 kHz				
		for **BC 153**		15		μS
		for **BC 154**		16		μS

BC 153
BC 154

Typical output characteristics
(for **BC 153** only)

Typical output characteristics
(for **BC 154** only)

DC transconductance

Typical DC current gain
(for **BC 153** only)

Typical DC current gain
(for **BC 154** only)

Typical normalized h parameters

Typical noise figure (for **BC 154** only)

Typical noise figure (for **BC 154** only)

Typical noise figure (for **BC 154** only)

Typical noise figure (for **BC 154** only)

TYPICAL APPLICATION FOR BC 154

Low noise preamplifier for magnetic heads

List of components

R_1 = 56 kΩ
R_2 = 1.8 MΩ
R_3 = 1.5 MΩ
R_4 = 180 kΩ
R_5 = 220 Ω
R_6 = 47 kΩ
R_7 = 180 kΩ
R_8 = 8.2 kΩ
R_9 = 3.9 kΩ
R_{10} = 150 Ω
R_{11} = 1 kΩ
P_1 = 25 kΩ lin. (volume)
C_1 = 30 μF/15 V
C_2 = 50 μF/30 V
C_3 = 33 nF 5%
C_4 = 10 nF 5%
C_5 = 50 μF/6 V
C_6 = 30 μF/15 V
Q_1 = BC 154
Q_2 = BC 113

All the resistences are at 10%; 1/4 W

Overall performance

Supply Voltage	30 V
Supply Current	4 mA
Nominal Output Voltage	200 mV
THD (V_o = 200 mV; f = 1 kHz)	0,1 %
Sensitivity (V_o = 200 mV; f = 1 kHz)	4.5 mV
Signal to Noise Ratio (at nominal output voltage)	65 dB
Equalization (according to RIAA; 20 to 20000 Hz)	± 1 dB
Input Impedance	47 kΩ
Input Overload (at nominal sensitivity)	28 dB

SILICON PLANAR PNP

BC 160
BC 161

GENERAL PURPOSE TRANSISTORS

The BC 160 and BC 161 are silicon planar epitaxial PNP transistors in TO-39 metal case. They are particularly designed for audio amplifiers and switching applications up to 1 A.
The complementary NPN types are the BC 140 and BC 141.

ABSOLUTE MAXIMUM RATINGS

		BC 160	BC 161
V_{CBO}	Collector-base voltage ($I_E = 0$)	-60 V	-80 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-40 V	-60 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-5 V	
I_C	Collector current	-1 A	
I_B	Base current	-0.1 A	
P_{tot}	Total power dissipation at $T_{amb} \leq 25\,°C$	0.8 W	
	at $T_{case} \leq 25\,°C$	4 W	
T_{stg}	Storage temperature	-55 to 200 °C	
T_j	Junction temperature	200 °C	

MECHANICAL DATA

Dimensions in mm

(sim. to **TO-39**)

BC 160
BC 161

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	44	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	220	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	V_{CB} = -50 V			-200	nA
		V_{CB} = -50 V T_{amb} = 150°C			-200	µA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage ($I_E = 0$)	I_C = -100 µA				
		for **BC 160**	-60			V
		for **BC 161**	-80			V
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage ($I_B = 0$)	I_C = -10 mA				
		for **BC 160**	-40			V
		for **BC 161**	-60			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	I_E = -100 µA	-5			V
$V_{CE\ (sat)}$*	Collector-emitter saturation voltage	I_C = -0.1 A I_B = -10 mA		-0.1		V
		I_C = -0.5 A I_B = -50 mA		-0.35		V
		I_C = -1 A I_B = -0.1 A		-0.6	-1	V
V_{BE}*	Base-emitter voltage	I_C = -1 A V_{CE} = -1 V		-1.1	-1.6	V
h_{FE}*	DC current gain	I_C = -100 µA V_{CE} = -1 V				
		for **BC 160-161**		110		—
		for **BC 160-161** Gr. 6		46		—
		for **BC 160-161** Gr. 10		80		—
		I_C = -100 mA V_{CE} = -1 V				
		for **BC 160-161**	40	140	250	—
		for **BC 160-161** Gr. 6	40	63	100	—
		for **BC 160-161** Gr. 10	63	100	160	—
		I_C = -1 A V_{CE} = -1 V				
		for **BC 160-161**		26		—
		for **BC 160-161** Gr. 6		15		—
		for **BC 160-161** Gr. 10		20		—

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{FE_1}/h_{FE_2}	Matched pair ratio	I_C = -100 mA V_{CE} = -1 V			1.25	—
f_T	Transition frequency	I_C = -50 mA V_{CE} = -10 V	50			MHz
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = -20 V f = 1 MHz		15		pF
t_{on}	Turn-on time	I_C = -100 mA I_{B1} = -5 mA			500	ns
t_{off}	Turn-off time	I_C = -100 mA I_{B1} = I_{B2} = -5 mA			650	ns

* Pulsed: pulse duration = 300 μs, duty factor = 1%.

SILICON PLANAR PNP

BC 177
BC 178
BC 179

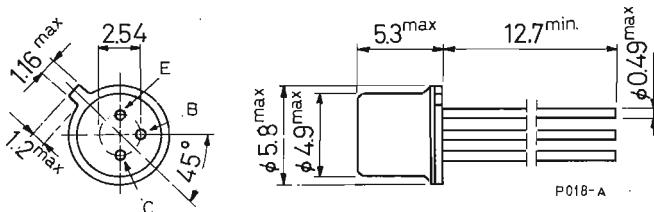
LOW NOISE GENERAL PURPOSE AUDIO AMPLIFIERS

The BC 177, BC 178 and BC 179 are silicon planar epitaxial PNP transistors in TO-18 metal case. They are suitable for use in driver audio stages, low noise input audio stages and as low power, high gain general purpose transistors. The complementary NPN types are respectively the BC 107, BC 108, BC 109.

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	BC 177	BC 178	BC 179
V_{CBO}	Collector-base voltage ($I_E = 0$)	-50 V	-30 V	-25 V
→ V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	-45 V	-25 V	-20 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-45 V	-25 V	-20 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-5 V		
→ I_{EM}	Emitter peak current	200 mA		
I_C	Collector current	-100 mA		
→ I_{CM}	Collector peak current	-200 mA		
P_{tot}	Total power dissipation at $T_{amb} \leq 25\,°C$	300 mW		
	at $T_{case} \leq 115\,°C$	300 mW		
T_{stg}	Storage temperature	-65 to 175 °C		
T_j	Junction temperature	175 °C		

MECHANICAL DATA

Dimensions in mm

(sim. to **TO-18**)

BC 177
BC 178
BC 179

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	200	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	500	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = -20 V		-1	-100	nA
$V_{(BR)\ CEO}$	Collector-emitter breakdown voltage (I_B = 0)	I_C = -2 mA				
		for **BC 177**	-45			V
		for **BC 178**	-25			V
		for **BC 179**	-20			V
$V_{(BR)\ CES}$	Collector-emitter breakdown voltage (V_{BE} = 0)	I_C = -10 μA				
		for **BC 177**	-50			V
		for **BC 178**	-30			V
		for **BC 179**	-25			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = -10 μA	-5			V
$V_{CE\ (sat)}$	Collector-emitter saturation voltage	I_C = -10 mA, I_B = -0.5 mA		-75	-250	mV
		I_C = -100 mA, I_B = -5 mA		-200		mV
V_{BE}	Base-emitter voltage	I_C = -2 mA V_{CE} = -5 V	-600	-640	-750	mV
$V_{BE\ (sat)}$	Base-emitter saturation voltage	I_C = -10 mA, I_B = -0.5 mA		-720		mV
		I_C = -100 mA, I_B = -5 mA		-860		mV
h_{FE}	DC current gain	I_C = -10 μA V_{CE} = -5 V	30			—

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{fe}	Small signal current gain	I_C = -2 mA V_{CE} = -5 V f = 1 kHz				
		for **BC 177** Gr. 6	75		150	—
		for **BC 177** Gr. A	125		260	—
		for **BC 178** Gr. 6	75		150	—
		for **BC 178** Gr. A	125		260	—
		for **BC 178** Gr. B	240		500	—
		for **BC 179** Gr. A	125		260	—
		for **BC 179** Gr. B	240		500	—
f_T	Transition frequency	I_C = -10 mA V_{CE} = -5 V		200		MHz
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = -10 V		5.5		pF
NF	Noise figure	I_C = -0.2 mA V_{CE} = -5 V R_g = 2 kΩ f = 1 kHz B = 200 Hz				
		for **BC 177**		2	10	dB
		for **BC 178**		2	10	dB
		for **BC 179**		1.2	4	dB
h_{ie}	Input impedance	I_C = -2 mA V_{CE} = -5 V f = 1 kHz				
		for **BC 177** Gr. 6		1.5		kΩ
		for **BC 177** Gr. A		2.7		kΩ
		for **BC 178** Gr. 6		1.5		kΩ
		for **BC 178** Gr. A		2.7		kΩ
		for **BC 178** Gr. B		5.2		kΩ
		for **BC 179** Gr. A		2.7		kΩ
		for **BC 179** Gr. B		5.2		kΩ
h_{re}	Reverse voltage ratio	I_C = -2 mA V_{CE} = -5 V f = 1 kHz				
		for **BC 177** Gr. 6		1.8×10^{-4}		—
		for **BC 177** Gr. A		2.7×10^{-4}		—
		for **BC 178** Gr. 6		1.8×10^{-4}		—
		for **BC 178** Gr. A		2.7×10^{-4}		—
		for **BC 178** Gr. B		4.5×10^{-4}		—
		for **BC 179** Gr. A		2.7×10^{-4}		—
		for **BC 179** Gr. B		4.5×10^{-4}		—

BC 177
BC 178
BC 179

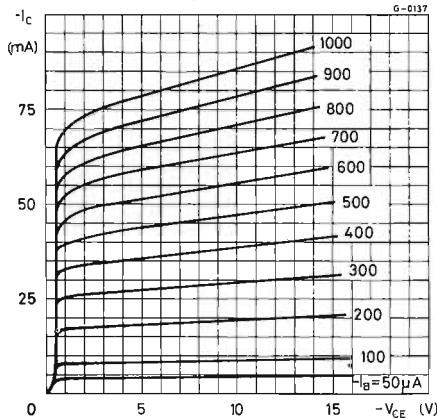
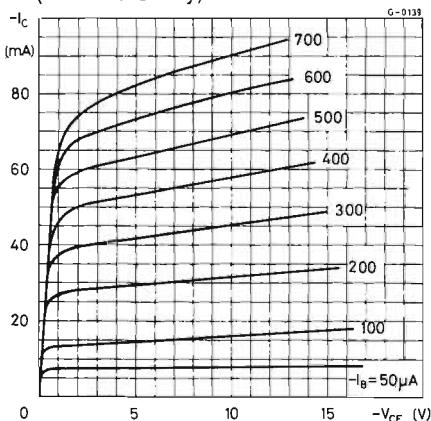
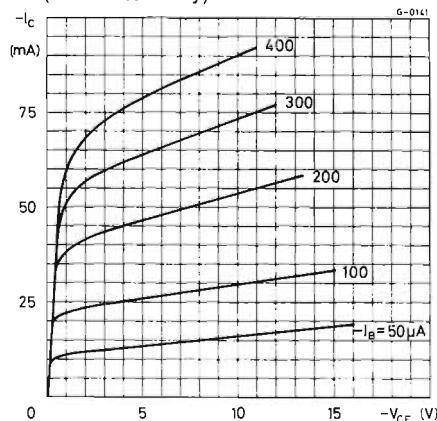
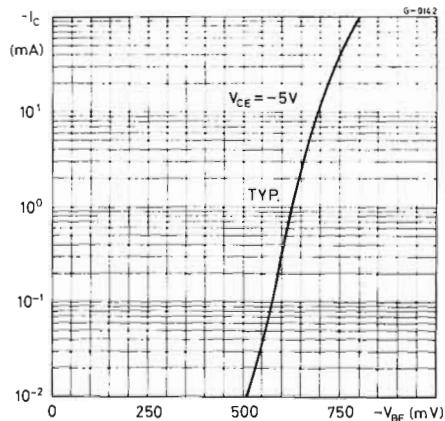
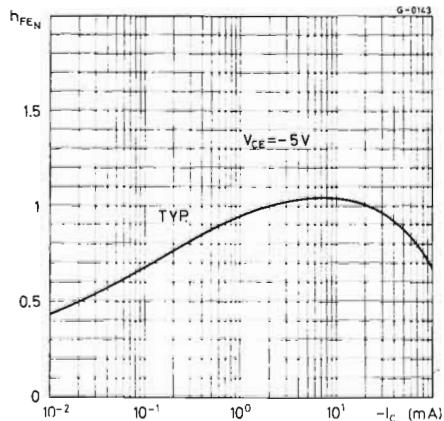
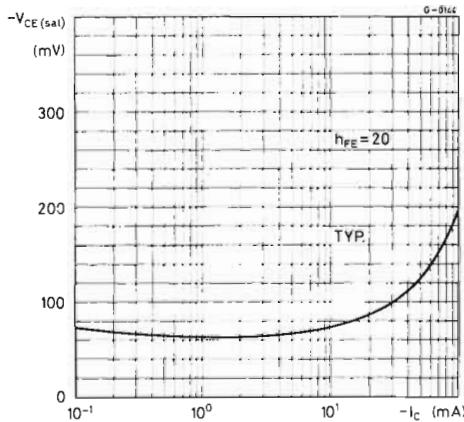
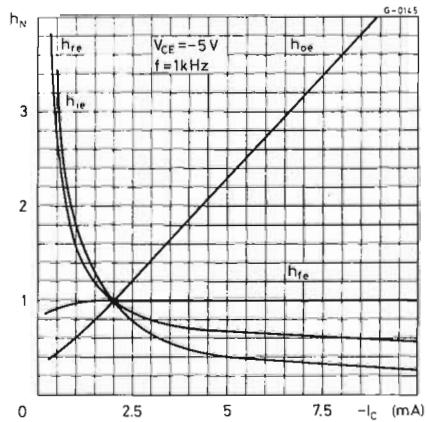
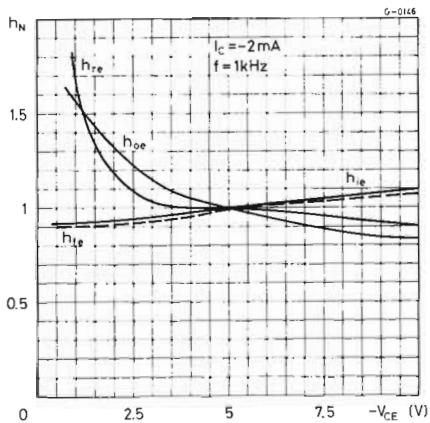
ELECTRICAL CHARACTERISTICS (continued)

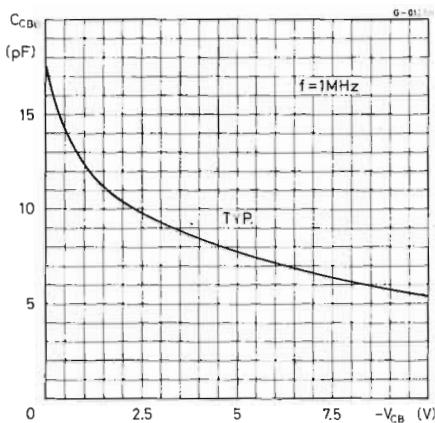
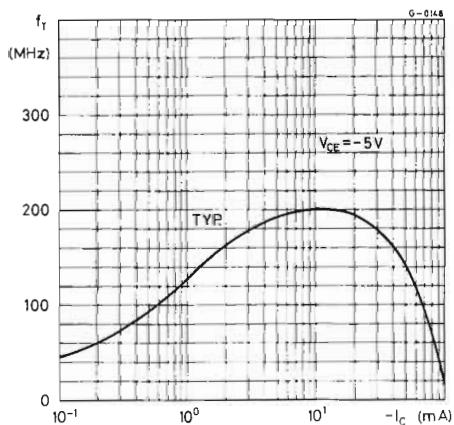
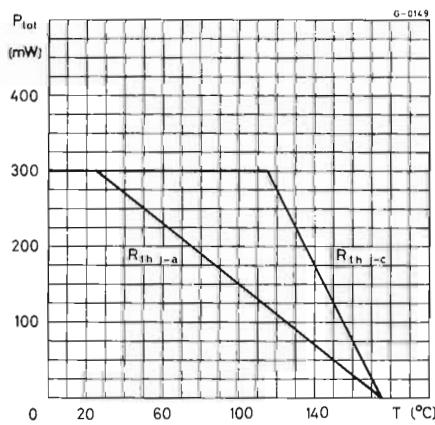
Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{oe}	Output admittance	I_C = -2 mA V_{CE} = -5 V f = 1 kHz				
		for **BC 177** Gr. 6		20		μS
		for **BC 177** Gr. A		25		μS
		for **BC 178** Gr. 6		20		μS
		for **BC 178** Gr. A		25		μS
		for **BC 178** Gr. B		35		μS
		for **BC 179** Gr. A		25		μS
		for **BC 179** Gr. B		35		μS

Typical output characteristics
(for **BC 177** only)

Typical output characteristics
(for **BC 178** only)

Typical output characteristics
(for **BC 179** only)

Typical output characteristics
(for **BC 177** only)

Typical output characteristics
(for **BC 178** only)

Typical output characteristics
(for **BC 179** only)

DC transconductance

DC normalized current gain

Collector-emitter saturation voltage

Typical normalized h parameters

Typical normalized h parameters

Collector-base capacitance

Transition frequency

Power rating chart

SILICON PLANAR PNP

BC 204
BC 205
BC 206

GENERAL PURPOSE AMPLIFIERS

The BC 204, BC 205 and BC 206 are silicon planar epitaxial PNP transistors in TO-18 epoxy package. They are intended for general amplifier applications and TV signal processing.

ABSOLUTE MAXIMUM RATINGS

		BC 204	BC 205 BC 206
V_{CBO}	Collector-base voltage ($I_E = 0$)	-50 V	-25 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-45 V	-20 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-5 V	
I_C	Collector current	-100 mA	
P_{tot}	Total power dissipation at $T_{amb} \leq 25\,°C$	0.2 W	
	at $T_{case} \leq 25\,°C$	0.5 W	
T_{stg}	Storage temperature	-55 to 125 °C	
T_j	Junction temperature	125 °C	

MECHANICAL DATA

Dimensions in mm

TO-18 epoxy

BC 204
BC 205
BC 206

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	200	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	500	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

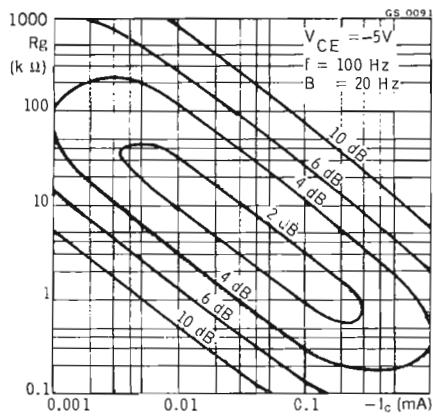
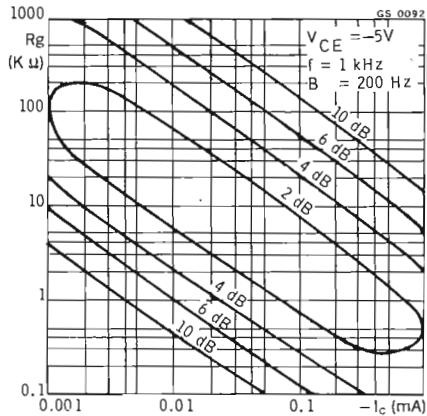
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	for **BC 204**				
		V_{CB} = -45 V			-50	nA
		V_{CB} = -45 V T_{amb} = 65 °C			-3	μA
		for **BC 205-BC 206**				
		V_{CB} = -20 V			-50	nA
		V_{CB} = -20 V T_{amb} = 65 °C			-3	μA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage ($I_E = 0$)	I_C = -10 μA				
		for **BC 204**	-50			V
		for **BC 205-BC 206**	-25			V
$V_{(BR)\ CEO}$	Collector-emitter breakdown voltage ($I_B = 0$)	I_C = -5 mA				
		for **BC 204**	-45			V
		for **BC 205-BC 206**	-20			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	I_E = -10μA	-5			V
$V_{CE\ (sat)}$	Collector-emitter saturation voltage	I_C = -10 mA I_B = -0.5 mA		-0.1	-0.3	V
V_{BE}	Base-emitter voltage	I_C = -2 mA V_{CE} = -5 V	-0.55	-0.65	-0.75	V

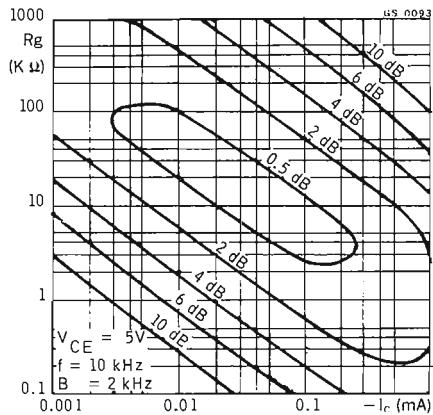
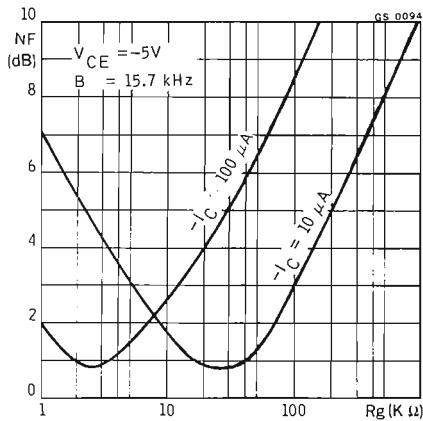
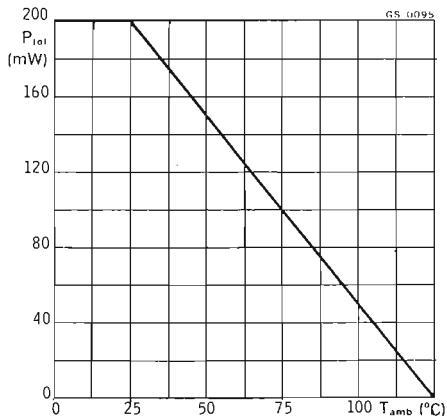
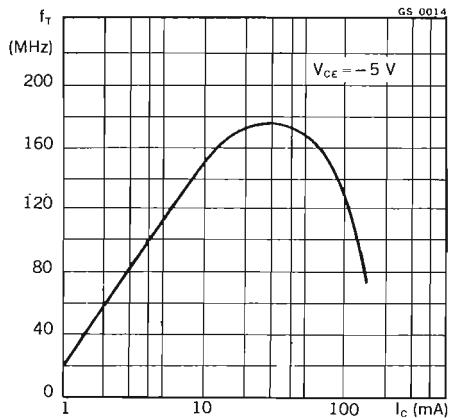
ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{FE}	DC current gain	I_C = -2 mA V_{CE} = -5 V				
		for **BC 204**	50	160	450	—
		for **BC 204** Gr. VI	50	90	120	—
		for **BC 204** Gr. A	110	180	220	—
		for **BC 204** Gr. B	200	300	450	—
		for **BC 205**	110	270	450	—
		for **BC 205** Gr. A	110	180	220	—
		for **BC 205** Gr. B	200	350	450	—
		for **BC 206**	200	400		—
		for **BC 206** Gr. B	200	350	450	—
		I_C = -10 µA V_{CE} = -5 V				
		for **BC 204**		110		—
		for **BC 204** Gr. VI		80		—
		for **BC 204** Gr. A		130		—
		for **BC 204** Gr. B		200		—
		for **BC 205**		200		—
		for **BC 205** Gr. A		130		—
		for **BC 205** Gr. B		270		—
		for **BC 206**		320		—
		for **BC 206** Gr. B		270		—
f_T	Transition frequency	I_C = -10 mA V_{CE} = -5 V		160		MHz
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = -10 V f = 1 MHz		4		pF
NF	Noise figure	I_C = -200 µA V_{CE} = -5 V f = 1 kHz B = 200 Hz				
		for **BC 204/205**		2	10	dB
		for **BC 206**		1	4	dB

DC normalized current gain

DC transconductance

Typical noise figure

Typical noise figure

Typical noise figure

Typical noise figure

Power rating chart

Transition frequency

SILICON PLANAR NPN

BC 207
BC 208
BC 209

GENERAL PURPOSE AUDIO AMPLIFIERS

The BC 207, BC 208 and BC 209 are silicon planar epitaxial NPN transistors in TO-18 epoxy package. They are intended for use in driver or input stages of audio amplifier and in signal processing circuits of TV receivers.

ABSOLUTE MAXIMUM RATINGS

		BC 207	BC 208 BC 209
V_{CBO}	Collector-base voltage ($I_E = 0$)	50 V	25 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	45 V	20 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	5 V	
I_C	Collector current	100 mA	
P_{tot}	Total power dissipation at $T_{amb} \leq 25\ °C$	0.2 W	
	at $T_{case} \leq 25\ °C$	0.5 W	
T_{stg}	Storage temperature	-55 to 125 °C	
T_j	Junction temperature	125 °C	

MECHANICAL DATA

Dimensions in mm

TO-18 epoxy

BC 207
BC 208
BC 209

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	200	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	500	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	V_{CB} = 40 V			50	nA
		V_{CB} = 40 V T_{amb} = 65 °C			50	µA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage ($I_E = 0$)	I_C = 10 µA				
		for **BC 207**	50			V
		for **BC 208-BC 209**	25			V
$V_{(BR)\ CEO}$	Collector-emitter breakdown voltage ($I_B = 0$)	I_C = 10 mA				
		for **BC 207**	45			V
		for **BC 208-BC 209**	20			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	I_E = 10 µA	5			V
$V_{CE\ (sat)}$*	Collector-emitter saturation voltage	I_C = 10 mA I_B = 0.5 mA			0.25	V
		I_C = 100 mA I_B = 5 mA			0.6	V
h_{FE}	DC current gain	I_C = 2 mA V_{CE} = 5 V				
		for **BC 207**	110	230	450	—
		for **BC 207** Gr. A	110	180	220	—
		for **BC 207** Gr. B	200	290	450	—
		for **BC 208**	110	350	800	—
		for **BC 208** Gr. A	110	180	220	—
		for **BC 208** Gr. B	200	290	450	—
		for **BC 208** Gr. C	420	520	800	—
		for **BC 209**	200	350	800	—
		for **BC 209** Gr. B	200	290	450	—
		for **BC 209** Gr. C	420	520	800	—

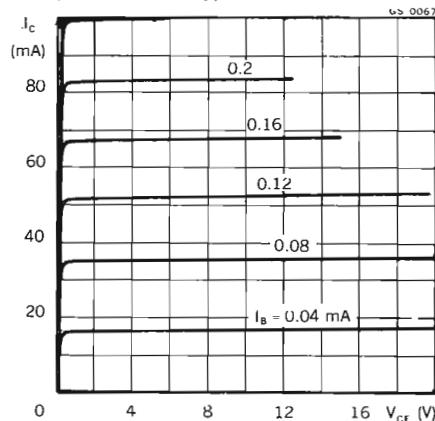
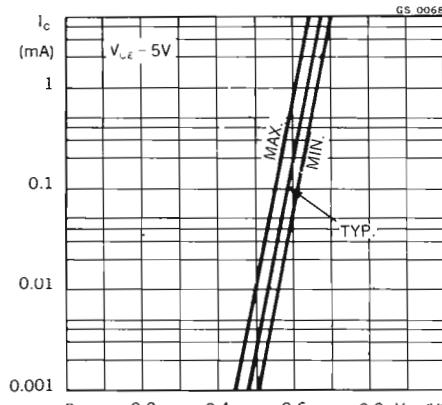
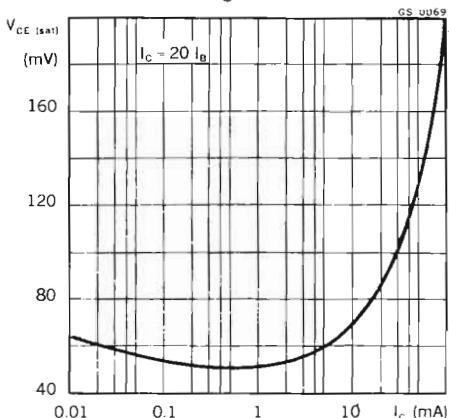
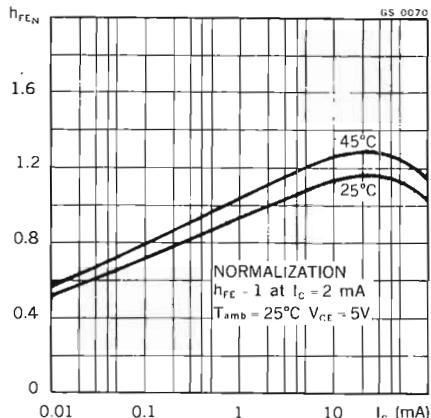
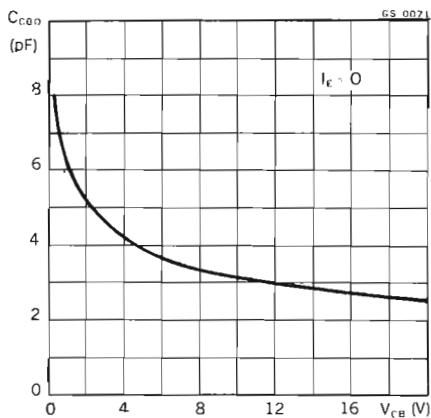
* Pulsed: pulse duration = 300 µs, duty factor = 1%.

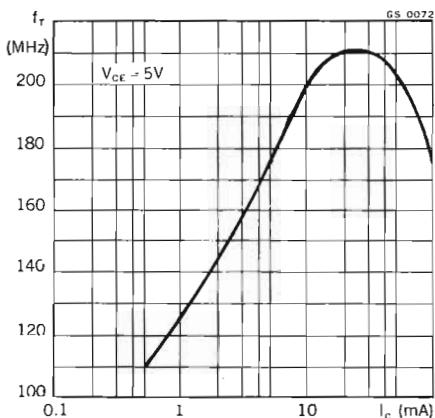
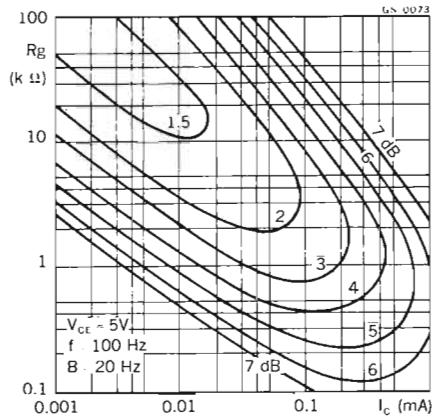
ELECTRICAL CHARACTERISTICS (continued)

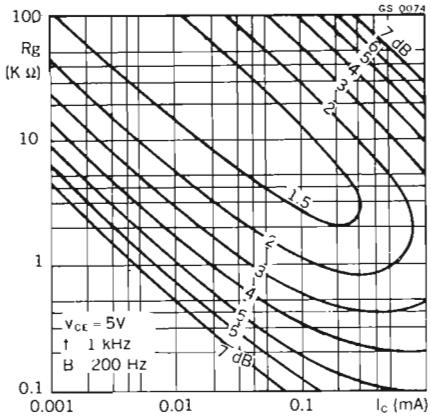
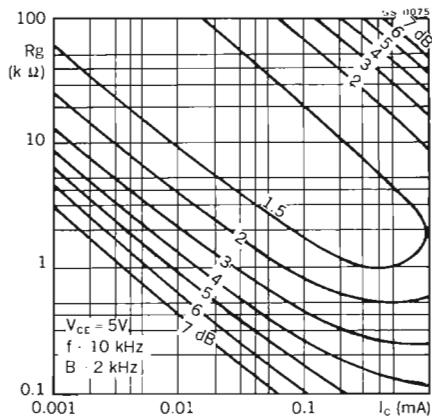
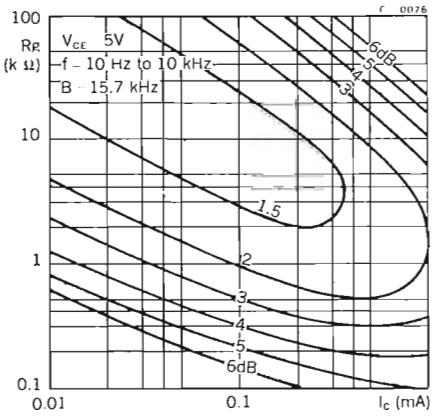
	Parameter	Test conditions	Min.	Typ.	Max.	Unit
h_{FE}	DC current gain	I_C = 10 µA V_{CE} = 5 V				
		for **BC 207**		120		—
		for **BC 207** Gr. A		90		—
		for **BC 207** Gr. B	40	150		—
		for **BC 208**		120		—
		for **BC 208** Gr. A		90		—
		for **BC 208** Gr. B	40	150		—
		for **BC 208** Gr. C	100	270		—
		for **BC 209**	70	210		—
		for **BC 209** Gr. B	40	150		—
		for **BC 209** Gr. C	100	270		—
f_T	Transition frequency	V_{CE} = 5 V I_C = 10 mA		200		MHz
NF	Noise figure	I_C = 0.2 mA V_{CE} = 5 V R_g = 2 kΩ f = 1 kHz B = 200 Hz				
		for **BC 207**		2	10	dB
		for **BC 208**		2	10	dB
		for **BC 209**		1.5	4	dB
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = 10 V f = 1 MHz		3.1	6	pF
h_{ie}	Input impedance	I_C = 2 mA V_{CE} = 5 V f = 1 kHz				
		for **BC 207**		4		kΩ
		for **C 207** Gr. A		3		kΩ
		for **BC 207** Gr. B		4.8		kΩ
		for **BC 208**		5.5		kΩ
		for **BC 208** Gr. A		3		kΩ
		for **BC 208** Gr. B		4.8		kΩ
		for **BC 208** Gr. C		7		kΩ
		for **BC 209**		5.5		kΩ
		for **BC 209** Gr. B		4.8		kΩ
		for **BC 209** Gr. C		7		kΩ
h_{oe}	Output admittance	I_C = 2 mA V_{CE} = 5 V f = 1 kHz				
		for **BC 207**		20		µS
		for **BC 207** Gr. A		13		µS
		for **BC 207** Gr. B		26		µS

ELECTRICAL CHARACTERISTICS (continued)

h_{oe}	Output admittance	for **BC 208** for **BC 208** Gr. A for **BC 208** Gr. B for **BC 208** Gr. C for **BC 209** for **BC 209** Gr. B for **BC 209** Gr. C	30 13 26 34 30 26 34	µS µS µS µS µS µS µS
h_{re}	Reverse voltage ratio	I_C = 2 mA V_{CE} = 5 V f = 1 kHz for **BC 207** for **BC 207** Gr. A for **BC 207** G . B for **BC 208** for **BC 208** Gr. A for **BC 208** Gr. B for **BC 208** Gr. C for **BC 209** for **BC 209** Gr. B for **BC 209** Gr. C	 2.7×10^{-4} 1.7×10^{-4} 3.7×10^{-4} 3.1×10^{-4} 1.7×10^{-4} 2.7×10^{-4} 3.8×10^{-4} 3.1×10^{-4} 2.7×10^{-4} 3.8×10^{-4}	 — — — — — — — — — —

Typical output characteristics
(for **BC 209** only)

DC transconductance

Typical collector-emitter saturation voltage

DC normalized current gain

Typical collector-base capacitance

Typical transition frequency

Typical noise figure (for **BC 209** only)

Typical noise figure (for **BC 209** only)

Typical noise figure (for **BC 209** only)

Typical noise figure (for **BC 209** only)

BC 225

SILICON PLANAR PNP

AUDIO AMPLIFIER

The BC 225 is a silicon planar PNP transistor in a TO-18 epoxy package. Designed for audio applications, it presents good current gain linearity from 10 μA to 50 mA.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-40	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-40	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-5	V
I_C	Collector current	-100	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25\,°C$	0.2	W
	at $T_{case} \leq 25\,°C$	0.5	W
T_{stg}	Storage temperature	-55 to 125	°C
T_j	Junction temperature	125	°C

MECHANICAL DATA

Dimensions in mm

TO-18 epoxy

BC 225

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	200	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	500	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	V_{CB} = -30 V			-100	nA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage ($I_E = 0$)	I_C = -10 μA	-40			V
$V_{(BR)\ CEO}$	Collector-emitter breakdown voltage ($I_B = 0$)	I_C = -5 mA	-40			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	I_E = -10 μA	-5			V
$V_{CE\ (sat)}$	Collector-emitter saturation voltage	I_C = -10 mA I_B = -0.5 mA		-0.1	-0.25	V
		I_C = -50 mA I_B = -5 mA		-0.16		V
V_{BE}	Base-emitter voltage	I_C = -1 mA V_{CE} = -5 V		-0.65		V
h_{FE}	DC current gain	I_C = -10 μA V_{CE} = -5 V		130		—
		I_C = -100 μA V_{CE} = -5 V	90	155		—
		I_C = -1 mA V_{CE} = -5 V	90	170		—
		I_C = -10 mA V_{CE} = -5 V	90	165		—
		I_C = -50 mA V_{CE} = -5 V		140		—
f_T	Transition frequency	I_C = -1 mA V_{CE} = -5 V		70		MHz
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = -5 V f = 1 MHz		4		pF
NF	Noise figure	I_C = -20 μA V_{CE} = -5 V R_g = 10 kΩ f = 1 kHz B = 200 Hz		1		dB
		I_C = -0.25 mA V_{CE} = -5 V R_g = 1 kΩ f = 1 kHz B = 200 Hz		1		dB

BC 288

SILICON PLANAR NPN

AUDIO OUTPUT AMPLIFIER

The BC 288 is a silicon planar epitaxial NPN transistor in a TO-39 metal case. It is designed to be used in low voltage audio output stages and is available as a pair 2 BC 288.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	80	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	40	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	6	V
I_C	Collector current	5	A
P_{tot}	Total power dissipation at $T_{amb} \leq 25\,°C$	0.8	W
	at $T_{case} \leq 25\,°C$	7	W
T_{stg}	Storage temperature	-55 to 200	°C
T_j	Junction temperature	200	°C

MECHANICAL DATA

Dimensions in mm

(sim. to **TO-39**)

BC 288

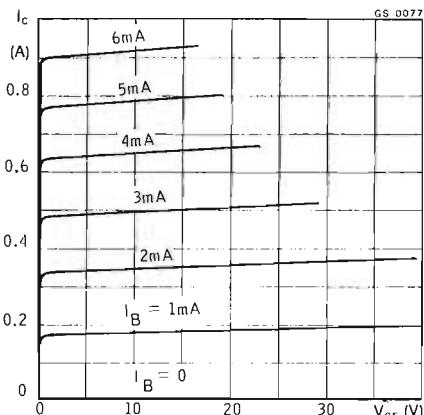
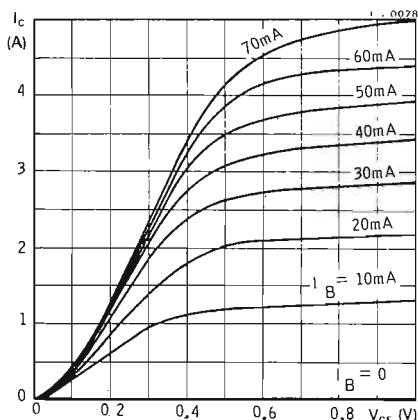
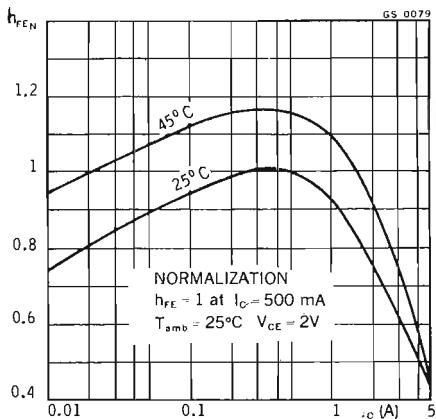
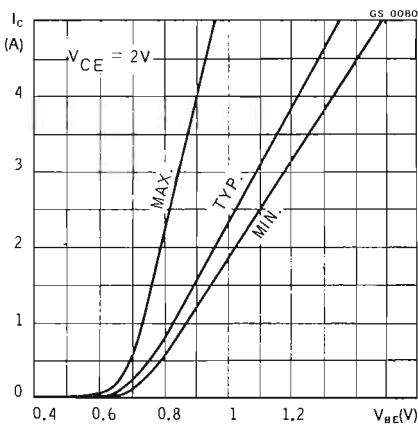
THERMAL DATA

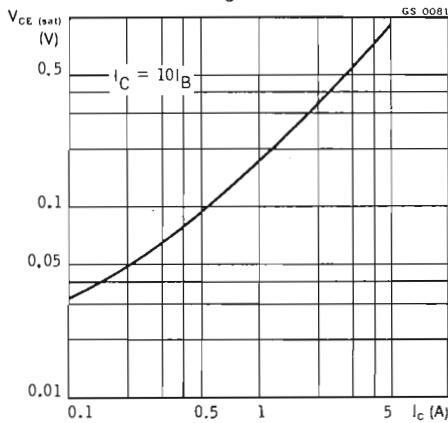
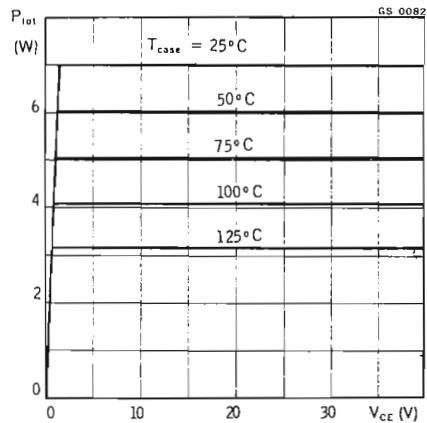
$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	25	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	220	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = 30 V			10	μA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 1 mA	80			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage (I_B = 0)	I_C = 50 mA	40			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = 1 mA	6			V
$V_{CE\ (sat)}$*	Collector-emitter saturation voltage	I_C = 2 A I_B = 0.2 A		0.35	0.6	V
V_{BE}*	Base-emitter voltage	I_C = 2 A V_{CE} = 2 V		0.95		V
h_{FE}*	DC current gain	I_C = 100 mA V_{CE} = 2 V		150		—
		I_C = 500 mA V_{CE} = 2 V		160		—
		I_C = 2 A V_{CE} = 2 V	30	120	200	—
h_{FE_1}/h_{FE_2}	Matched pair	I_C = 300 mA V_{CE} = 5 V			1.4	—
f_T	Transition frequency	I_C = 2 A V_{CE} = 2 V		80		MHz
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = 10 V		45		pF

* Pulsed: pulse duration = 300 μs, duty factor = 1%.

Typical output characteristics

Typical output characteristics

Normalized DC current gain

DC transconductance

BC 288

Typical collector-emitter saturation voltage

Power rating chart

BC 297
BC 298

SILICON PLANAR PNP

AUDIO DRIVERS OR OUTPUT STAGES

The BC 297 and BC 298 are silicon planar epitaxial PNP transistors in TO-18 metal case. They are particularly intended for use in high current high gain applications, in driver stages of hi-fi equipments or in output stages of low power class B amplifiers.

The complementary NPN types are the BC 377 and BC 378, respectively.

ABSOLUTE MAXIMUM RATINGS

		BC 297	BC 298
V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	-50 V	-30 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-45 V	-25 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-5 V	
I_E	Emitter current	1.2 A	
I_C	Collector current	-1 A	
I_B	Base current	-0.2 A	
P_{tot}	Total power dissipation at $T_{amb} \leq 25\ °C$	375 mW	
	at $T_{case} \leq 75\ °C$	1 W	
T_{stg}	Storage temperature	-65 to 175 °C	
T_j	Junction temperature	175 °C	

MECHANICAL DATA

Dimensions in mm

(sim. to **TO-18**)

BC 297
BC 298

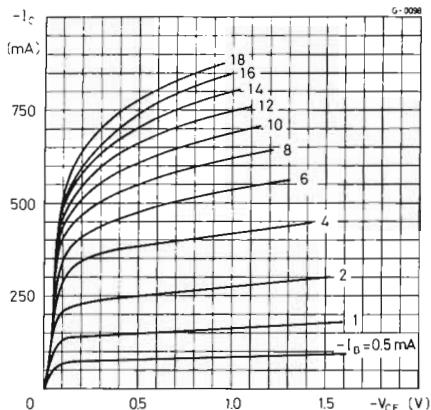
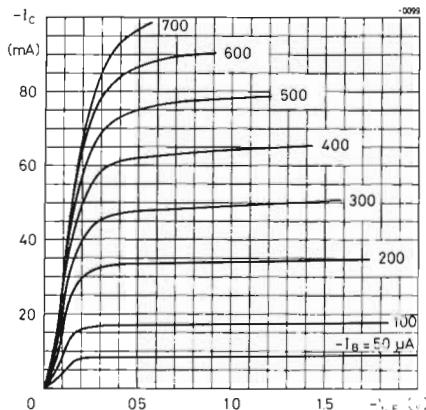
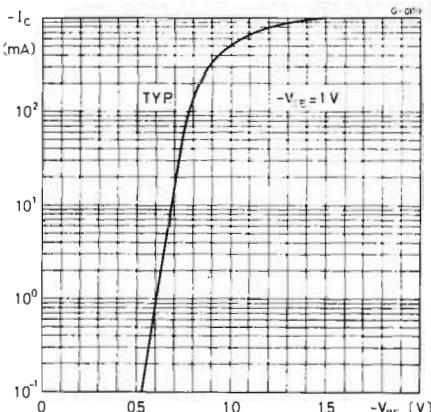
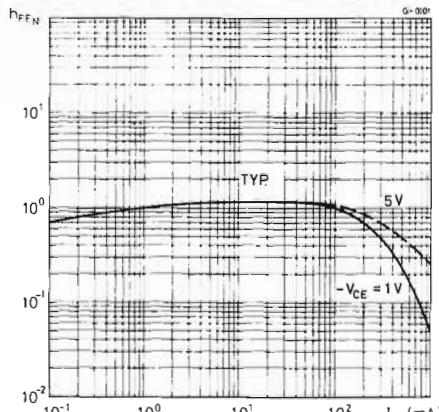
THERMAL DATA

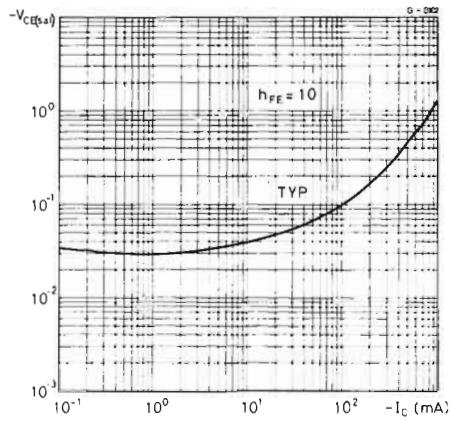
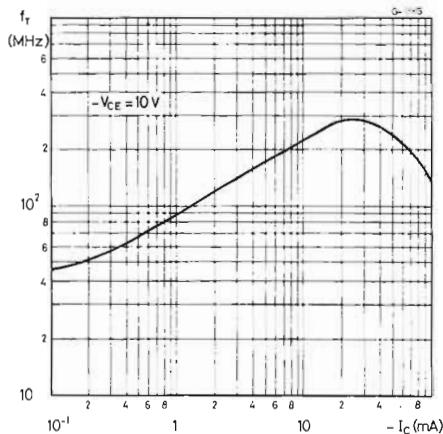
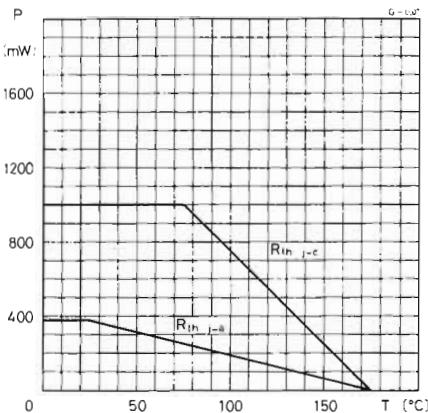
$R_{th\ j-case}$	Thermal resistance junction-case	max	100	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	400	°C/W

ELECTRICAL CHARACTERISTICS (T_{case} = 25 °C unless otherwise specified)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
	I_{CES} Collector cutoff current (V_{BE} = 0)	for **BC 297** V_{CE} = -50 V			-100	nA
		for **BC 298** V_{CE} = -30 V			-100	nA
	$V_{(BR)\ CEO}$ Collector-emitter breakdown voltage (I_B = 0)	I_C = -10 mA for **BC 297**	-45			V
		for **BC 298**	-25			V
→	$V_{(BR)\ EBO}$ Emitter-base breakdown voltage (I_C = 0)	I_E = -10 μA	-5			V
	$V_{CE\ (sat)}$ Collector-emitter saturation voltage	I_C = -500 mA I_B = -50 mA			-0.7	V
	V_{BE} Base-emitter voltage	I_C = -100 mA V_{CE} = -1 V		-770		mV
	$V_{BE\ (sat)}$ Base-emitter saturation voltage	I_C = -500 mA I_B = -50 mA			-1.2	V
→	h_{FE} DC current gain Gr. 6	I_C = -100 mA V_{CE} = -1 V	75		150	—
	Gr. 7	I_C = -100 mA V_{CE} = -1 V	125		260	—
		I_C = -300 mA V_{CE} = -1 V	30			—
	h_{FE_1}/h_{FE_2} Matched pair ratio	I_C = -100 mA V_{CE} = -1 V			1.41	—
→	f_T Transition frequency	I_C = -50 mA V_{CE} = -10 V		250		MHz
→	C_{CBO} Collector-base capacitance	I_E = 0 V_{CB} = -10 V		8		pF
→	C_{EBO} Emitter-base capacitance	I_C = 0 V_{EB} = -0.5 V		30		pF

BC 297
BC 298

Typical output characteristics

Typical output characteristics

DC transconductance

DC normalized current gain

BC 297
BC 298

Collector-emitter saturation voltage

Typical transition frequency

Power rating chart

SILICON PLANAR NPN

BC 300
BC 301
BC 302

MEDIUM POWER AUDIO DRIVERS

The BC 300, BC 301 and BC 302 are silicon planar epitaxial NPN transistors in TO-39 metal case. They are intended for audio driver stages in commercial and industrial equipments. In addition they are useful as high speed saturated switches and general purpose amplifiers. The PNP types complementary to BC 301 and BC 302 are respectively the BC 303 and BC 304.

ABSOLUTE MAXIMUM RATINGS

		BC 300	BC 301	BC 302
V_{CBO}	Collector-base voltage ($I_E = 0$)	120 V	90 V	60 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	80 V	60 V	45 V
V_{CEV}	Collector-emitter voltage ($V_{BE} = -1.5$ V)	120 V	90 V	—
V_{EBO}	Emitter-base voltage ($I_C = 0$)		7 V	
I_C	Collector current		0.5 A	
I_{CM}	Collector peak current		1 A	
I_{BM}	Base peak current		0.5 A	
P_{tot}	Total power dissipation at $T_{amb} \leq 25$ °C		0.85 W	
	at $T_{case} \leq 25$ °C		6 W	
T_{stg}	Storage temperature		-65 to 175 °C	
T_j	Junction temperature		175 °C	

MECHANICAL DATA

Dimensions in mm

(sim. to **TO-39**)

BC 300
BC 301
BC 302

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	25	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	175	°C/W

ELECTRICAL CHARACTERISTICS (T_{case} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	V_{CB} = 60 V		5	20	nA
I_{EBO}	Emitter cutoff current ($I_C = 0$)	V_{EB} = 7 V			20	nA
$V_{CEO(sus)}$*	Collector-emitter voltage ($I_B = 0$)	I_C = 100 mA				
		for **BC 300**	80			V
		for **BC 301**	60			V
		for **BC 302**	45			V
$V_{CEV(sus)}$*	Collector-emitter voltage	I_C = 100 mA V_{BE} = -1.5 V				
		for **BC 300**	120			V
		for **BC 301**	90			V
$V_{CE\ (sat)}$	Collector-emitter saturation voltage	I_C = 150 mA I_B = 15 mA		0.2	0.5	V
V_{BE}	Base-emitter voltage	I_C = 150 mA V_{CE} = 10 V		0.78		V
h_{FE}	DC current gain Gr. 4	I_C = 150 mA V_{CE} = 10 V	40		80	—
	Gr. 5	I_C = 150 mA V_{CE} = 10 V	70		140	—
	Gr. 6	I_C = 150 mA V_{CE} = 10 V	120		240	—
		I_C = 0.1 mA V_{CE} = 10 V	20			—
		I_C = 500 mA V_{CE} = 10 V	20			—
f_T	Transition frequency	I_C = 10 mA V_{CE} = 10 V		120		MHz
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = 10 V		10		pF
h_{ie}	Input impedance	I_C = 5 mA V_{CE} = 10 V; f = 1 kHz		1.1		kΩ

* Pulsed; pulse duration = 300 µs, duty factor = 1.5%.

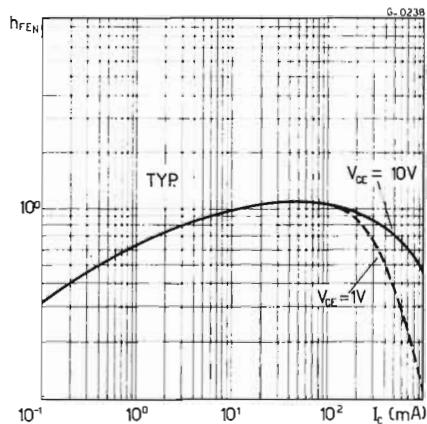
ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min. Typ. Max.	Unit
h_{re}	Reverse voltage ratio	I_C = 5 mA V_{CE} = 10 V f = 1 kHz	1.7×10^{-4}	—
h_{fe}	Small signal current gain	I_C = 5 mA V_{CE} = 10 V f = 1 kHz	140	—
h_{oe}	Output admittance	I_C = 5 mA V_{CE} = 10 V f = 1 kHz	14	μS

Typical output characteristics

DC transconductance

BC 300
BC 301
BC 302

DC normalized current gain

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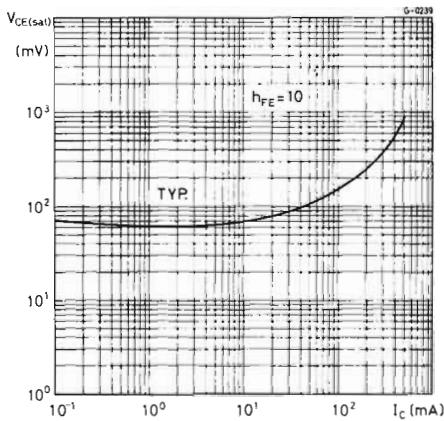
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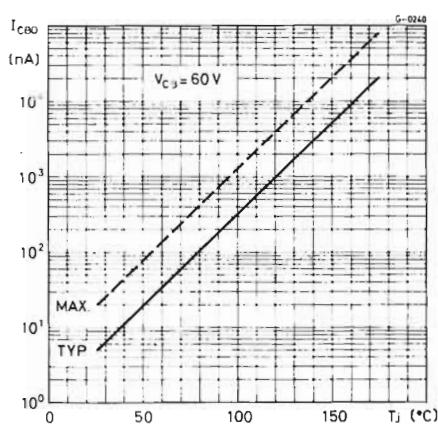
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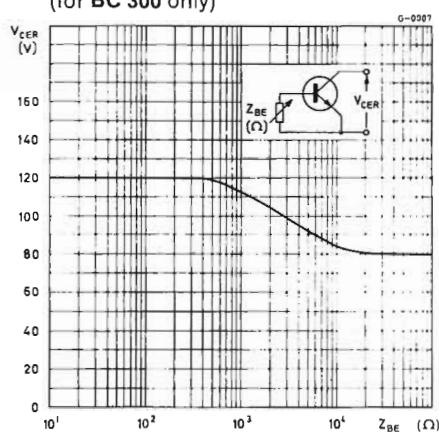
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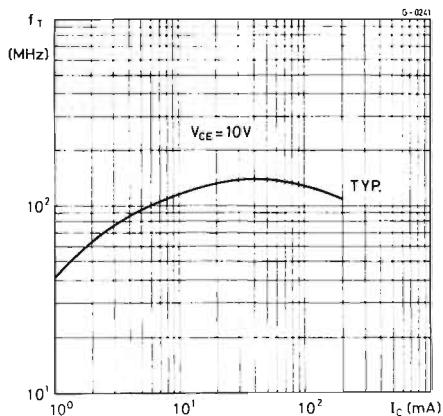
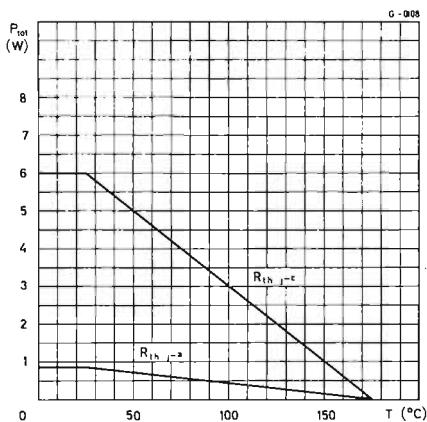

Power rating chart

SILICON PLANAR PNP

BC 303
BC 304

MEDIUM POWER AUDIO DRIVERS

The BC 303 and BC 304 are silicon planar epitaxial PNP transistors in TO-39 metal case. They are intended particularly as audio driver stages in commercial and professional equipments. In addition they are useful as high speed saturated switches and general purpose amplifiers. The complementary NPN types are respectively the BC 301 and BC 302.

ABSOLUTE MAXIMUM RATINGS

		BC 303	BC 304
V_{CBO}	Collector-base voltage ($I_E = 0$)	-85 V	-60 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-60 V	-45 V
V_{CEV}	Collector-emitter voltage ($V_{BE} = 1.5$ V)	-85 V	—
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-7 V	
I_C	Collector current	-0.5 A	
I_{CM}	Collector peak current	-1 A	
I_{BM}	Base peak current	-0.5 A	
P_{tot}	Total power dissipation at $T_{amb} \leq 25\,°C$	0.85 W	
	at $T_{case} \leq 25\,°C$	6 W	
T_{stg}	Storage temperature	-65 to 175 °C	
T_j	Junction temperature	175 °C	

MECHANICAL DATA

Dimensions in mm

(sim. to **TO-39**)

BC 303
BC 304

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	25	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	175	°C/W

ELECTRICAL CHARACTERISTICS (T_{case} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	V_{CB} = -60 V		-5	-20	nA
I_{EBO}	Emitter cutoff current ($I_C = 0$)	V_{EB} = -5 V			-20	nA
$V_{CEO(sus)}$*	Collector-emitter voltage ($I_B = 0$)	I_C = -100 mA				
		for **BC 303**	-60			V
		for **BC 304**	-45			V
$V_{CEV(sus)}$*	Collector-emitter voltage (for **BC 303** only)	I_C = -100 mA V_{BE} = 1.5 V	-85			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_C = -150 mA I_B = -15 mA		-0.25	-0.65	V
V_{BE}	Base-emitter voltage	I_C = -150 mA V_{CE} = -10 V		-0.78		V
h_{FE}	DC current gain Gr. 4	I_C = -150 mA V_{CE} = -10 V	40		80	—
	Gr. 5	I_C = -150 mA V_{CE} = -10 V	70		140	—
	Gr. 6	I_C = -150 mA V_{CE} = -10 V	120		240	—
		I_C = 0.1 mA V_{CE} = -10 V	20			—
		I_C = -500 mA V_{CE} = -10 V	20			—
f_T	Transition frequency	I_C = -10 mA V_{CE} = -10 V		75		MHz
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = -10 V		15		pF
h_{ie}	Input impedance	I_C = -5 mA V_{CE} = -10 V f = 1 kHz		0.9		kΩ

* Pulsed: pulse duration = 300 μs, duty factor = 1.5%.

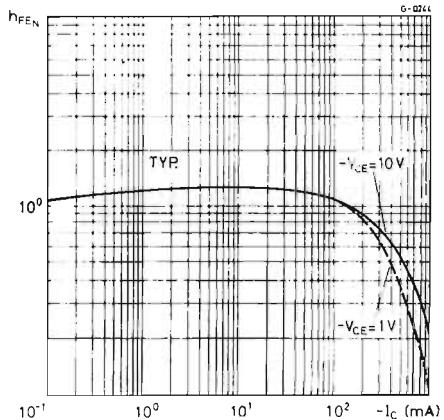
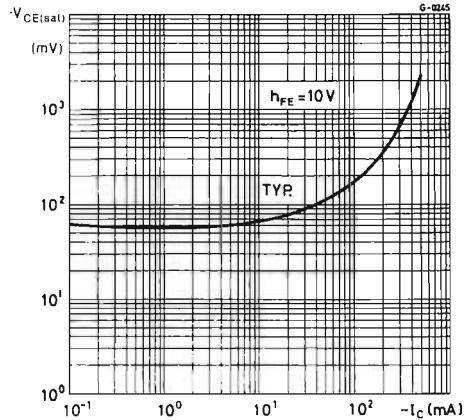
ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min. Typ. Max.	Unit
h_{re}	Reverse voltage ratio	I_C = -5 mA V_{CE} = -10 V f = 1 kHz	1.7×10^{-4}	—
h_{fe}	Small signal current gain	I_C = -5 mA V_{CE} = -10 V f = 1 kHz	140	—
h_{oe}	Output admittance	I_C = -5 mA V_{CE} = -10 V f = 1 kHz	45	μS

Typical output characteristics

DC transconductance

BC 303
BC 304

DC normalized current gain

Collector-emitter saturation voltage

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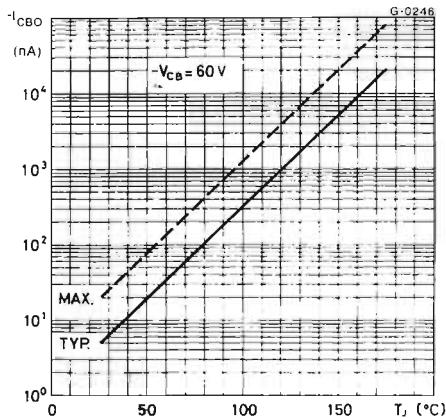
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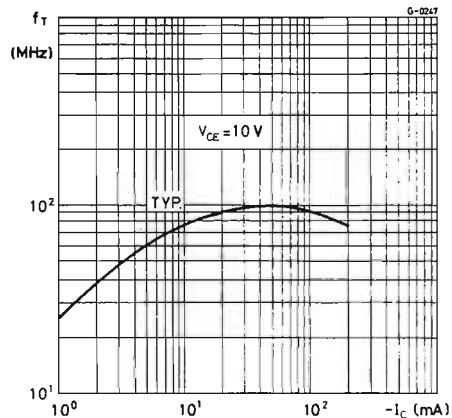

BC 323

SILICON PLANAR NPN

TV VERTICAL OUTPUT AMPLIFIER

The BC 323 is a silicon planar epitaxial NPN transistor in a TO-39 metal case. It is designed as the output stage of a vertical deflection amplifier for TV receivers.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	100	V
V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	100	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	60	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	5	V
I_C	Collector current	5	A
P_{tot}	Total power dissipation at $T_{amb} \leq 25$ °C	0.8	W
	at $T_{case} \leq 25$ °C	7	W
T_{stg}	Storage temperature	-55 to 200	°C
T_j	Junction temperature	200	°C

MECHANICAL DATA

Dimensions in mm

(sim. to **TO-39**)

BC 323

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	25	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	220	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	V_{CB} = 40 V V_{CB} = 40 V T_{amb} = 75 °C		0.02 0.35	10	μA μA
$V_{(BR)\ CES}$	Collector-emitter breakdown voltage ($V_{BE} = 0$)	I_C = 1 mA	100			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage ($I_B = 0$)	I_C = 50 mA	60			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	I_E = 1 mA	5			V
$V_{CE\ (sat)}$*	Collector-emitter saturation voltage	I_C = 500 mA I_B = 50 mA		0.07	0.15	V
$V_{BE\ (sat)}$*	Base-emitter saturation voltage	I_C = 500 mA I_B = 50 mA		0.7	0.9	V
h_{FE}*	DC current gain	I_C = 50 mA V_{CE} = 1 V I_C = 500 mA V_{CE} = 1 V	45 50	140 160	225 250	— —
f_T	Transition frequency	I_C = 500 mA V_{CE} = 5 V		100		MHz
C_{EBO}	Emitter-base capacitance ($I_C = 0$)	V_{EB} = 0.5 V			500	pF
C_{CBO}	Collector-base capacitance ($I_E = 0$)	V_{CB} = 10 V			80	pF

* Pulsed: pulse duration = 300 μs, duty factor = 1%.

SILICON PLANAR NPN

BC 377 BC 378

AUDIO DRIVERS OR OUTPUT STAGES

The BC 377 and BC 378 are silicon planar epitaxial NPN transistors in TO-18 metal case. They are particularly intended for use in high current, high gain applications, in driver stages of hi-fi equipments or in output stages of low power class B amplifiers. The complementary PNP types are the BC 297 and BC 298, respectively.

ABSOLUTE MAXIMUM RATINGS

		BC 377	BC 378
V_{CES}	Collector-emitter voltage ($V_{EB} = 0$)	50 V	30 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	45 V	25 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	6 V	
I_E	Emitter current	-1.2 A	
I_C	Collector current	1 A	
I_B	Base current	0.2 A	
P_{tot}	Total power dissipation at $T_{amb} \leq 25$ °C	375 mW	
	at $T_{case} \leq 75$ °C	1 W	
T_{stg}	Storage temperature	-65 to 175 °C	
T_j	Junction temperature	175 °C	

MECHANICAL DATA

Dimensions in mm

(sim. to **TO-18**)

BC 377
BC 378

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	100	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	400	°C/W

ELECTRICAL CHARACTERISTICS (T_{case} = 25 °C unless otherwise specified)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
	I_{CES} Collector cutoff current (V_{BE} = 0)	for **BC 377** V_{CE} = 50 V			15	nA
		for **BC 378** V_{CE} = 30 V			15	nA
→	$V_{(BR)\ EBO}$ Emitter-base breakdown voltage (I_C = 0)	I_E = 10 μA	6			V
	$V_{(BR)\ CEO}$ Collector-emitter breakdown voltage (I_B = 0)	I_C = 2 mA for **BC 377**	45			V
		for **BC 378**	25			V
	$V_{CE\ (sat)}$ Collector-emitter saturation voltage	I_C = 500 mA I_B = 50 mA			0.7	V
	V_{BE} Base-emitter voltage	I_C = 100 mA V_{CE} = 1 V		740		mV
	$V_{BE\ (sat)}$ Base-emitter saturation voltage	I_C = 500 mA I_B = 50 mA			1.2	V
→	h_{FE} DC current gain Gr. 6	I_C = 100 mA V_{CE} = 1 V	75		150	—
	Gr. 7	I_C = 100 mA V_{CE} = 1 V	125		260	—
		I_C = 300 mA V_{CE} = 1 V	40			—
	h_{FE_1}/h_{FE_2} Matched pair ratio	I_C = 100 mA V_{CE} = 1 V			1.41	—
→	f_T Transition frequency	I_C = 50 mA V_{CE} = 10 V		300		MHz
→	C_{CBO} Collector-base capacitance	I_E = 0 V_{CB} = 10 V		8		pF
→	C_{EBO} Emitter-base capacitance	I_C = 0 V_{EB} = 0.5 V		30		pF

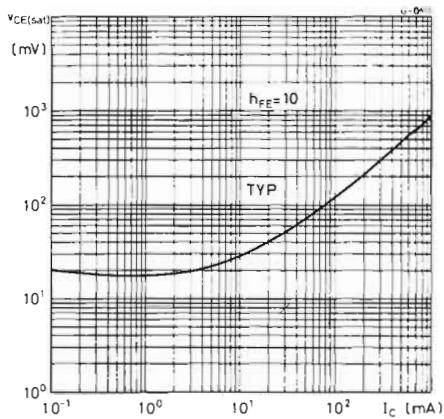
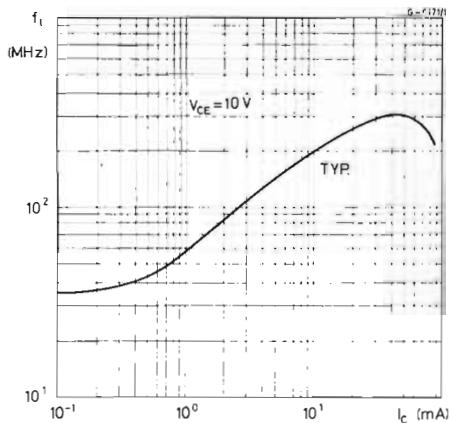
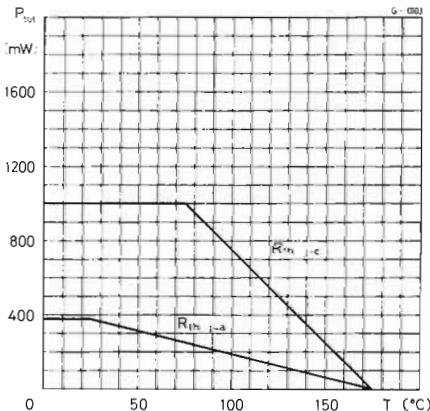
Typical output characteristics

Typical output characteristics

DC transconductance

DC normalized current gain

BC 377
BC 378

Collector-emitter saturation voltage

Transition frequency

Power rating chart

BC 440
BC 441

SILICON PLANAR NPN

MEDIUM POWER AMPLIFIER

The BC 440 and BC 441 are silicon planar epitaxial NPN transistors in TO-39 metal case. They are intended for general purpose applications, especially for driver stages.
The complementary PNP types are respectively the BC 460 and BC 461.

ABSOLUTE MAXIMUM RATINGS

		BC 440	BC 441
V_{CBO}	Collector-base voltage ($I_E = 0$)	50 V	75 V
$V_{CEO\ (sus)}$	Collector-emitter voltage ($I_B = 0$)	40 V	60 V
V_{CER}	Collector-emitter voltage ($R_{BE} \leq 100\ \Omega$)	50 V	75 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	5 V	
I_{CM}	Collector peak current	2 A	
I_{BM}	Base peak current	1 A	
P_{tot}	Total power dissipation at $T_{amb} \leq 25\ °C$	1 W	
	at $T_{case} \leq 25\ °C$	10 W	
T_{stg}	Storage temperature	-65 to 200 °C	
T_j	Junction temperature	200 °C	

MECHANICAL DATA

Dimensions in mm

(sim. to **TO-39**)

BC 440
BC 441

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	17.5	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	175	°C/W

ELECTRICAL CHARACTERISTICS (T_{case} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	$V_{CB} = 40$ V			100	nA
I_{CER}	Collector cutoff current ($R_{BE} = 100\ \Omega$)	for **BC 440** $V_{CE} = 50$ V for **BC 441** $V_{CE} = 70$ V			10 10	µA µA
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 100$ µA	5			V
$V_{CEO(sus)}$	Collector-emitter voltage ($I_B = 0$)	$I_C = 100$ mA for **BC 440** for **BC 441**	40 60			V V
$V_{CE\ (sat)}$	Collector-emitter saturation voltage	$I_C = 1$ A $I_B = 100$ mA			1	V
$V_{BE\ (sat)}$	Base-emitter saturation voltage	$I_C = 1$ A $I_B = 100$ mA			1.5	V
h_{FE}	DC current gain Gr. 4	$I_C = 500$ mA $V_{CE} = 4$ V	40		70	—
	Gr. 5	$I_C = 500$ mA $V_{CE} = 4$ V	60		130	—
	Gr. 6	$I_C = 500$ mA $V_{CE} = 4$ V	115		250	—
		$I_C = 1$ A $V_{CE} = 2$ V (for **BC 440** only)	20			—
h_{FE_1}/h_{FE_2}	Matched pair ratio	$I_C = 500$ mA $V_{CE} = 4$ V			1.4	—
f_T	Transition frequency	$I_C = 50$ mA $V_{CE} = 4$ V	50			MHz

Typical output characteristics

Typical DC transconductance

Typical DC normalized current gain

Collector cutoff current

Typical collector-emitter saturation voltage

SILICON PLANAR PNP

BC 460
BC 461

MEDIUM POWER AMPLIFIER

The BC 460 and BC 461 are silicon planar epitaxial PNP transistors in TO-39 metal case. They are intended for general purpose applications, especially for driver stages.
The complementary NPN types are respectively the BC 440 and BC 441.

ABSOLUTE MAXIMUM RATINGS

		BC 460	BC 461
V_{CBO}	Collector-base voltage ($I_E = 0$)	-50 V	-75 V
$V_{CEO\ (sus)}$	Collector-emitter voltage ($I_B = 0$)	-40 V	-60 V
V_{CER}	Collector-emitter voltage ($R_{BE} \leq 100\ \Omega$)	-50 V	-75 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-5 V	
I_{CM}	Collector peak current	-2 A	
I_{BM}	Base peak current	-1 A	
P_{tot}	Total power dissipation at $T_{amb} \leq 25\ °C$	1 W	
	at $T_{case} \leq 25\ °C$	10 W	
T_{stg}	Storage temperature	-65 to 200 °C	
T_j	Junction temperature	200 °C	

MECHANICAL DATA

Dimensions in mm

(sim. to **TO-39**)

BC 460
BC 461

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	17.5	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	175	°C/W

ELECTRICAL CHARACTERISTICS (T_{case} = 25 °C unless otherwise specified)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	$V_{CB} = -40$ V			-100	nA
I_{CER}	Collector cutoff current ($R_{BE} = 100\ \Omega$)	for **BC 460** $V_{CE} = -50$ V for **BC 461** $V_{CE} = -70$ V			-10 -10	μA μA
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	$I_E = -100\ \mu A$	-5			V
$V_{CEO(sus)}$	Collector-emitter voltage ($I_B = 0$)	$I_C = -100$ mA for **BC 460** for **BC 461**	-40 -60			V V
$V_{CE\ (sat)}$	Collector-emitter saturation voltage	$I_C = -1$ A $I_B = -100$ mA			-1	V
$V_{BE\ (sat)}$	Base-emitter saturation voltage	$I_C = -1$ A $I_B = -100$ mA			-1.5	V
h_{FE}	DC current gain Gr. 4	$I_C = -500$ mA $V_{CE} = -4$ V	40		70	—
	Gr. 5	$I_C = -500$ mA $V_{CE} = -4$ V	60		130	—
	Gr. 6	$I_C = -500$ mA $V_{CE} = -4$ V	115		250	—
		$I_C = -1$ A $V_{CE} = -2$ V (for **BC 460** only)	20			—
h_{FE_1}/h_{FE_2}	Matched pair ratio	$I_C = -500$ mA $V_{CE} = -4$ V			1.4	—
f_T	Transition frequency	$I_C = -50$ mA $V_{CE} = -4$ V	50			MHz

Typical output characteristics

Typical DC transconductance

Typical DC normalized current gain

Collector cutoff current

Typical collector-emitter saturation voltage

SILICON PLANAR PNP

BC 477
BC 478
BC 479

LOW NOISE GENERAL PURPOSE AUDIO AMPLIFIERS

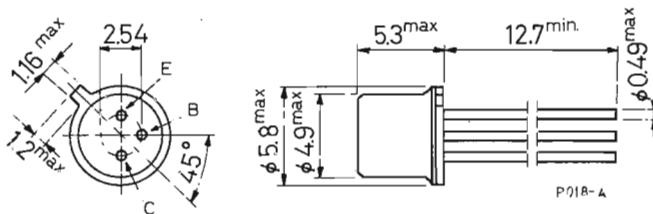
The BC 477, BC 478 and BC 479 are silicon planar epitaxial PNP transistors in TO-18 metal case.

The BC 477 is a high voltage type designed for use in audio amplifiers or driver stages, and in the signal processing circuits of TV sets. The BC 478 and BC 479 are respectively low noise and very low noise types, designed for general preamplifier or amplifier applications.

ABSOLUTE MAXIMUM RATINGS

		BC 477	BC 478	BC 479
V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	-90 V	-50 V	-40 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-80 V	-50 V	-40 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)		-6 V	
I_C	Collector current		-150 mA	
P_{tot}	Total power dissipation at $T_{amb} \leq 25\ °C$		0.36 W	
	at $T_{case} \leq 25\ °C$		1.2 W	
T_{stg}	Storage temperature		-55 to 200 °C	
T_j	Junction temperature		200 °C	

MECHANICAL DATA

Dimensions in mm

(sim. to **TO-18**)

BC 477
BC 478
BC 479

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	146	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	480	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	for **BC 477**				
		V_{CE} = -70 V			-10	nA
		V_{CE} = -70 V T_{amb} = 125°C			-10	μA
		for **BC 478**				
		V_{CE} = -40 V			-10	nA
		V_{CE} = -40 V T_{amb} = 125°C			-10	μA
		for **BC 479**				
		V_{CE} = -30 V			-10	nA
		V_{CE} = -30 V T_{amb} = 125°C			-10	μA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = -4 V			-10	nA
$V_{(BR)\ CES}$	Collector-emitter breakdown voltage (V_{BE} = 0)	I_C = -10 μA				
		for **BC 477**	-90			V
		for **BC 478**	-50			V
		for **BC 479**	-40			V
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage (I_B = 0)	I_C = -5 mA				
		for **BC 477**	-80			V
		for **BC 478**	-50			V
		for **BC 479**	-40			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = -10 μA	-6			V

* Pulsed: pulse duration = 300 μs, duty factor = 1%.

ELECTRICAL CHARACTERISTICS (continued)

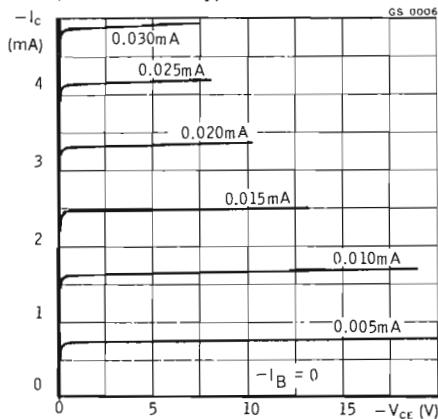
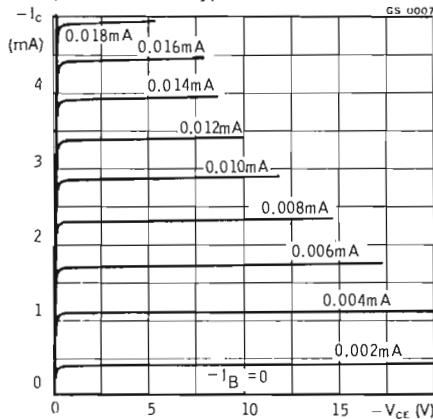
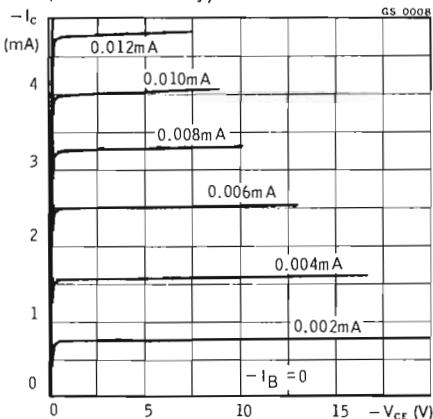
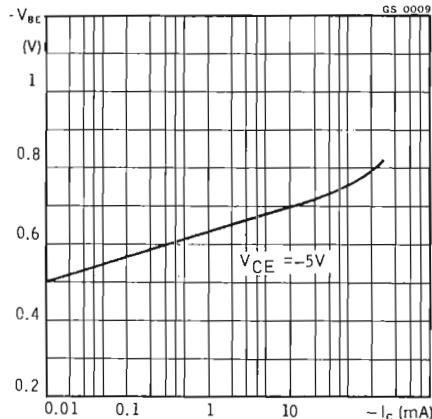
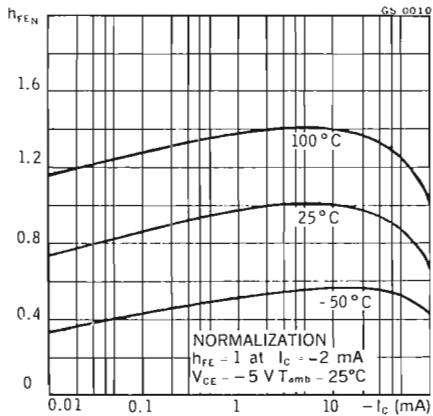
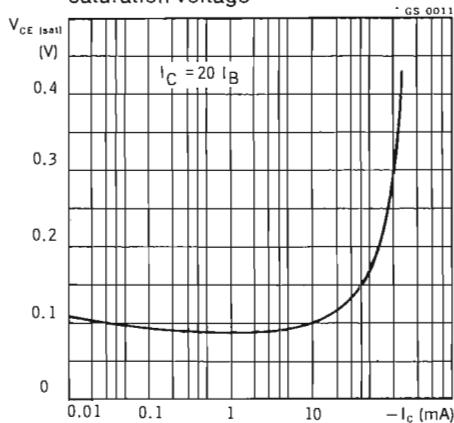
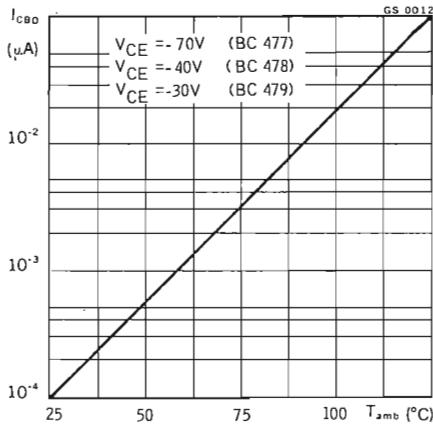
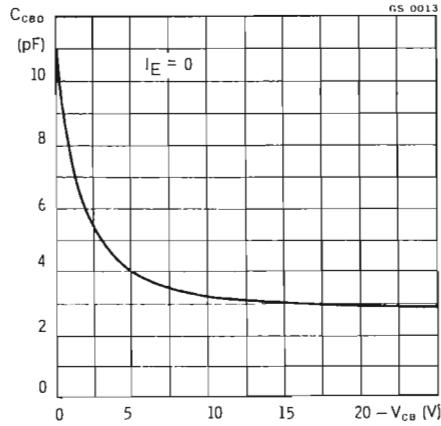
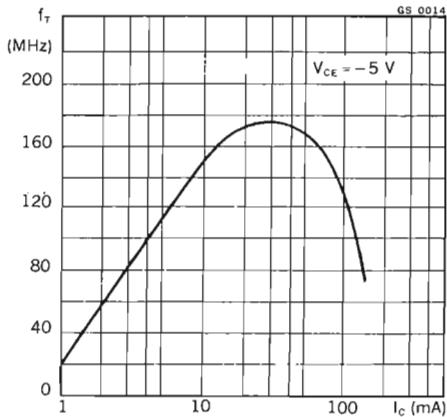
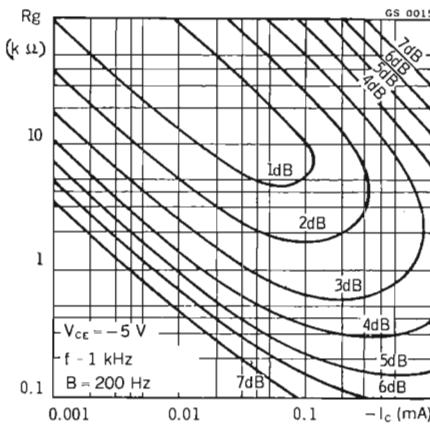
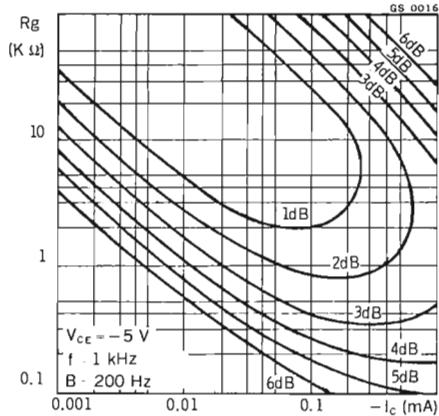
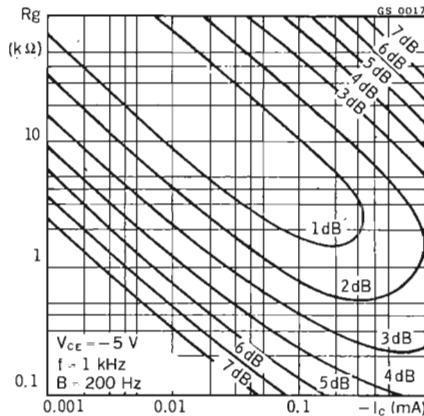
Parameter		Test conditions	Min.	Typ.	Max.	Unit
$V_{CE\,(sat)}$*	Collector-emitter saturation voltage	I_C = -10 mA, I_B = -0.5 mA		-0.1	-0.25	V
		I_C = -100 mA, I_B = -5 mA		-0.3		V
V_{BE}*	Base-emitter voltage	I_C = -2 mA V_{CE} = -5 V	-0.55	-0.65	-0.75	V
$V_{BE\,(sat)}$*	Base-emitter saturation voltage	I_C = -10 mA, I_B = -0.5 mA		-0.75	-0.9	V
		I_C = -100 mA, I_B = -5 mA		-0.9		V
h_{FE}*	DC current gain	I_C = -10 μA V_{CE} = -5 V				
		for **BC 477**	30	115		—
		for **BC 477** Gr. VI	30	70		—
		for **BC 477** Gr. A	50	130		—
		for **BC 478**	50	195		—
		for **BC 478** Gr. A	50	130		—
		for **BC 478** Gr. B	100	250		—
		for **BC 479**	100	290		—
		for **BC 479** Gr. B	100	250		—
		I_C = -2 mA V_{CE} = -5 V				
		for **BC 477**	70		250	—
		for **BC 477** Gr. VI	70		130	—
		for **BC 477** Gr. A	110		250	—
		for **BC 478**	110		450	—
		for **BC 478** Gr. A	110		250	—
		for **BC 478** Gr. B	220		450	—
		for **BC 479**	220			—
		for **BC 479** Gr. B	220		450	—
		I_C = -10 mA V_{CE} = -5 V				
		for **BC 477**		160		—
		for **BC 477** Gr. VI		100		—
		for **BC 477** Gr. A		180		—
		for **BC 478**		270		—
		for **BC 478** Gr. A		180		—
		for **BC 478** Gr. B		350		—
		for **BC 479**		400		—
		for **BC 479** Gr. B		350		—

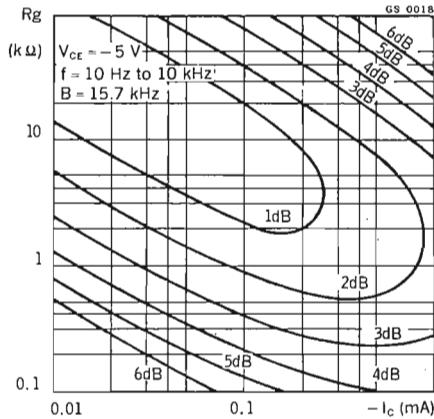
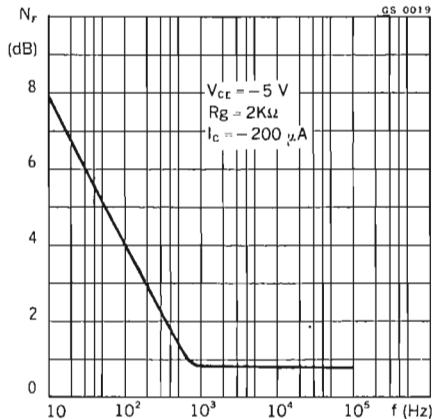
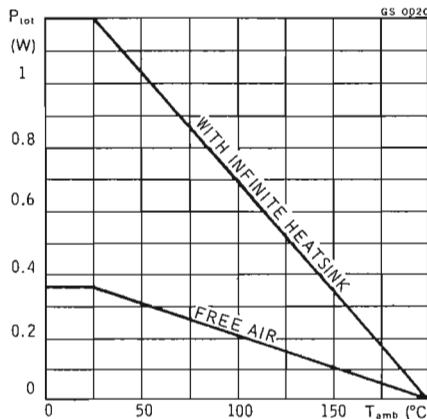
* Pulsed: pulse duration = 300 μs, duty factor = 1%.

BC 477
BC 478
BC 479

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{fe}	Small signal current gain	I_C = -2 mA V_{CE} = -5 V f = 1 kHz				
		for **BC 477**	75		260	—
		for **BC 477** Gr. VI	75		150	—
		for **BC 477** Gr. A	125		260	—
		for **BC 478**	125		500	—
		for **BC 478** Gr. A	125		260	—
		for **BC 478** Gr. B	240		500	—
		for **BC 479**	240			—
		for **BC 479** Gr. B	240		500	—
		I_C = -10 mA V_{CE} = -5 V f = 20 MHz		7.5		—
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = -5 V		4	6	pF
C_{EBO}	Emitter-base capacitance	I_C = 0 V_{EB} = -0.5 V		11	15	pF
NF	Noise figure	I_C = -20 μA V_{CE} = -5 V R_g = 10 kΩ f = 10 Hz to 10 kHz B = 15.7 kHz				
		for **BC 479**		0.8	3.5	dB
		I_C = -200 μA V_{CE} = -5 V R_g = 2 kΩ f = 10 Hz to 10 kHz B = 15.7 kHz				
		for **BC 478**		1.5		dB
		for **BC 479**		1	4	dB
		I_C = -20 μA V_{CE} = -5 V R_g = 10 kΩ f = 1 kHz B = 200 Hz				
		for **BC 479**		0.5	2.5	dB
		I_C = -200 μA V_{CE} = -5 V R_g = 2 kΩ f = 1 kHz B = 200 Hz				
		for **BC 477**		2	10	dB
		for **BC 478**		1.2	6	dB
		for **BC 479**		0.8	4	dB

Typical output characteristics
(for **BC 477** only)

Typical output characteristics
(for **BC 478** only)

Typical output characteristics
(for **BC 479** only)

DC transconductance

DC normalized current gain

Typical collector-emitter saturation voltage

Typical collector cutoff current

Typical collector-base capacitance

Transition frequency

Noise figure (for **BC 477** only)

Noise figure (for **BC 478** only)

Noise figure (for **BC 479** only)

BC 477
BC 478
BC 479

Noise figure (for **BC 479** only)

Noise figure (for **BC 479** only)

Power rating chart

SILICON PLANAR NPN

BF 155

UHF AMPLIFIER AND MIXER-OSCILLATOR

The BF 155 is a silicon planar NPN transistor in a TO-72 metal case. It is specifically designed for UHF amplifier and mixer-oscillator applications.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	40 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	40 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	3 V
I_C	Collector current	20 mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25$ °C	200 mW
	at $T_{case} \leq 25$ °C	300 mW
T_{stg}	Storage temperature	-55 to 200 °C
T_j	Junction temperature	200 °C

MECHANICAL DATA

Dimensions in mm

(sim. to **TO-72**)

BF 155

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	580	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	875	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	$V_{CB} = 10$ V			100	nA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage ($I_E = 0$)	$I_C = 100\ \mu A$	40			V
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = 5$ mA	40			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 100\ \mu A$	3			V
V_{BE}	Base-emitter voltage	$I_C = 2.5$ mA $V_{CE} = 12$ V			0.85	V
h_{FE}*	DC current gain	$I_C = 2.5$ mA $V_{CE} = 12$ V	20	70		—
f_T	Transition frequency	$I_C = 2.5$ mA $V_{CE} = 12$ V	400	600		MHz
$-C_{re}$	Feedback capacitance	$I_C = 2.5$ mA $V_{CE} = 12$ V f = 1 MHz		0.4		pF
NF	Noise figure	$I_C = 2.5$ mA $V_{CB} = 12$ V $R_g = 50\ \Omega$ f = 800 MHz		7	9	dB
G_{pb}	Power gain	$I_C = 2.5$ mA $V_{CB} = 12$ V f = 800 MHz	8	10		dB
f_{max}	Maximum oscillation frequency	$I_C = 2.5$ mA $V_{CB} = 12$ V		2.5		GHz

* Pulsed: pulse duration = 300 μs; duty factor = 1%.

SILICON PLANAR NPN

BF 158

IF AMPLIFIER FOR TV

The BF 158 is a silicon planar NPN transistor in a TO-18 epoxy package. It is designed for use as IF amplifier in TV receiver.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	30	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	12	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	2	V
P_{tot}	Total power dissipation at $T_{amb} \leq 25\,°C$	0.2	W
	at $T_{case} \leq 25\,°C$	0.5	W
T_{stg}	Storage temperature	-55 to 125	°C
T_j	Junction temperature	125	°C

MECHANICAL DATA

Dimensions in mm

TO-18 epoxy

BF 158

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	200	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	500	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	V_{CB} = 15 V			100	nA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage ($I_E = 0$)	I_C = 100 μA	30			V
$V_{CEO\ (sus)}$	Collector-emitter sustaining voltage ($I_B = 0$)	I_C = 3 mA	12			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	I_E = 100 μA	2			V
$V_{CE\ (sat)}$	Collector-emitter saturation voltage	I_C = 10 mA I_B = 1 mA			0.5	V
h_{FE}	DC current gain	I_C = 4 mA V_{CE} = 10 V	20	50		—
f_T	Transition frequency	I_C = 5 mA V_{CE} = 10 V		700		MHz
$-C_{re}$	Feedback capacitance	I_C = 5 mA V_{CE} = 10 V		0.8	1.2	pF
NF	Noise figure	I_C = 4 mA V_{CE} = 10 V R_g = 400 Ω f = 40 MHz		3.5		dB
G_{pe}	Power gain	I_C = 5 mA V_{CE} = 10 V f = 40 MHz	22	26		dB
g_{oe}	Output conductance	I_C = 5 mA V_{CE} = 10 V f = 40 MHz		0.2	0.3	mS

BF 160

SILICON PLANAR NPN

IF AMPLIFIER FOR AM/FM RADIOS

The BF 160 is a silicon planar NPN transistor in a TO-18 epoxy package. It is designed for intermediate frequency (5.5 MHz TV - 10.7 MHz FM) and for general AM-FM applications.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	30	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	12	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	2	V
P_{tot}	Total power dissipation at $T_{amb} \leq 25\,°C$	200	mW
	at $T_{case} \leq 25\,°C$	500	mW
T_{stg}	Storage temperature	-55 to 125	°C
T_j	Junction temperature	125	°C

MECHANICAL DATA

Dimensions in mm

TO-18 epoxy

BF 160

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	200	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	500	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	V_{CB} = 15 V V_{CB} = 15 V T_{amb} = 65°C			100 5	nA μA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage ($I_E = 0$)	I_C = 100 μA	30			V
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage ($I_B = 0$)	I_C = 3 mA	12			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	I_E = 100 μA	2			V
h_{FE}*	DC current gain	I_C = 3 mA V_{CE} = 10 V	20	50		—
f_T	Transition frequency	I_C = 3 mA V_{CE} = 10 V	400	600		MHz
$-C_{re}$	Feedback capacitance	I_C = 3 mA V_{CE} = 10 V		0.8	1.2	pF
G_{pe}	Power gain	I_C = 3 mA V_{CE} = 8 V f = 10.7 MHz	28	32		dB

* Pulsed: pulse duration = 300 μs, duty factor = 1%.

SILICON PLANAR NPN

BF 161

UHF AMPLIFIER, OSCILLATOR AND MIXER

The BF 161 is a silicon planar NPN transistor in a TO-72 metal case, intended for UHF tuner applications.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	50	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	50	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4	V
I_C	Collector current	20	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25\ °C$	175	mW
	at $T_{case} \leq 25\ °C$	260	mW
T_{stg}	Storage temperature	-55 to 175	°C
T_j	Junction temperature	175	°C

MECHANICAL DATA

Dimensions in mm

(sim. to **TO-72**)

BF 161

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	580	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)	V_{CB} = 10 V			100	nA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 50 μA	50			V
$V_{CEO\ (sus)}$	Collector-emitter sustaining voltage (I_B = 0)	I_C = 5 mA	50			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = 50μA	5			V
V_{BE}	Base-emitter voltage	I_C = 3 mA V_{CE} = 24 V		0.74		V
h_{FE}	DC current gain	I_C = 3 mA V_{CE} = 10 V	20	60		—
f_T	Transition frequency	I_C = 3 mA V_{CE} = 10 V	400	550		MHz
$-C_{re}$	Feedback capacitance	I_C = 3 mA V_{CE} = 10 V f = 1 MHz		0.3	0.45	pF
NF	Noise figure	I_C = 1.5 mA V_{CB} = 24 V f = 800 MHz		6.5		dB
G_{pb}	Power gain	I_C = 1.5 mA V_{CB} = 24 V f = 800 MHz		12		dB
	Collector current for ΔG_{pb} = 30 dB	V_{CC} = 12 V f = 800 MHz		8		mA

BF 166

SILICON PLANAR NPN

HIGH FREQUENCY GENERAL PURPOSE AMPLIFIER

The BF 166 is a silicon planar NPN transistor in a TO-72 metal case. It is designed to be used as a gain-controlled VHF amplifier.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	40	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	40	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	3	V
P_{tot}	Total power dissipation at $T_{amb} \leq 25$ °C	175	mW
	at $T_{case} \leq 25$ °C	260	mW
T_{stg}	Storage temperature	-55 to 175	°C
T_j	Junction temperature	175	°C

MECHANICAL DATA

Dimensions in mm

(sim. to **TO-72**)

BF 166

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	580	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	$V_{CB} = 10$ V			100	nA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage ($I_E = 0$)	$I_C = 100\ \mu A$	40			V
$V_{CEO\ (sus)}$	Collector-emitter sustaining voltage ($I_B = 0$)	$I_C = 1$ mA	40			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 10\ \mu A$	3			V
V_{BE}*	Base-emitter voltage	$I_C = 2.5$ mA $V_{CE} = 12$ V			0.9	V
h_{FE}*	DC current gain	$I_C = 2.5$ mA $V_{CE} = 12$ V	20	50		—
f_T	Transition frequency	$I_C = 3$ mA $V_{CE} = 12$ V	400	500		MHz
$-C_{re}$	Feedback capacitance	$I_C = 2.5$ mA $V_{CE} = 12$ V		0.4	0.6	pF
NF	Noise figure	$I_C = 2.5$ mA $V_{CE} = 12$ V $R_g = 50\ \Omega$ f = 200 MHz		3	5	dB
G_{pe}	Power gain (neutralized)	$I_C = 3$ mA $V_{CE} = 10$ V f = 200 MHz	16	18		dB
$I_{C\ (AGC)}$	Collector current for $\Delta G_{pb} = 30$ dB	$V_{CC} = 12$ V f = 200 MHz			14	mA

* Pulsed: pulse duration = 300 µs, duty factor = 1%.

BF 167

SILICON PLANAR NPN

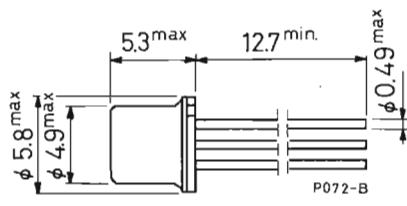
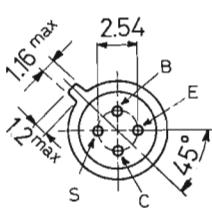
TV AGC IF AMPLIFIER

The BF 167 is a silicon planar NPN transistor in a TO-72 metal case. It is particularly designed for use in forward AGC IF amplifiers of TV receivers. It is characterized by very low feedback capacitance due to a screening diffusion under the base pad.

ABSOLUTE MAXIMUM RATINGS

V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	40	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	30	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4	V
I_C	Collector current	25	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25\ °C$	150	mW
T_{stg}	Storage temperature	-55 to 175	°C
T_j	Junction temperature	175	°C

MECHANICAL DATA

Dimensions in mm

(sim. to **TO-72**)

BF 167

THERMAL DATA

$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	1000	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = 10 V			50	nA
		V_{CE} = 10 V T_{amb} = 100°C			5	µA
$V_{(BR)\ CES}$	Collector-emitter breakdown voltage (V_{BE} = 0)	I_C = 10 µA	40			V
$V_{(BR)\ CEO}$	Collector-emitter breakdown voltage (I_B = 0)	I_C = 5 mA	30			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = 10 µA	4			V
V_{BE}*	Base-emitter voltage	I_C = 4 mA V_{CE} = 10 V		0.74		V
h_{FE}*	DC current gain	I_C = 1 mA V_{CE} = 10 V		35		—
		I_C = 4 mA V_{CE} = 10 V	30	45		—
		I_C = 10 mA V_{CE} = 10 V		20		—
f_T	Transition frequency	I_C = 4 mA V_{CE} = 10 V		600		MHz
$-C_{re}$	Feedback capacitance	I_C = 0 V_{CE} = 10 V f = 1 MHz		0.15		pF
NF	Noise figure	I_C = 4 mA V_{CE} = 10 V R_g = 100 Ω f = 36 MHz		3		dB
G_{pe}**	Power gain	I_E = 4 mA V_{CE} = 10 V f = 36 MHz	24	28		dB

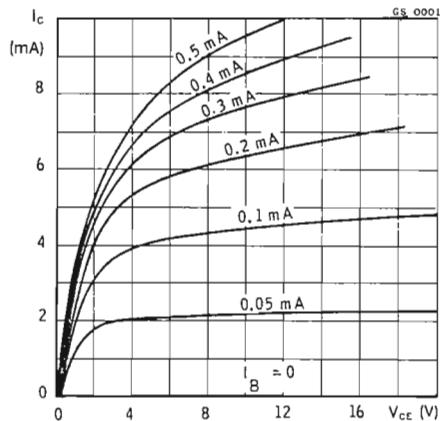
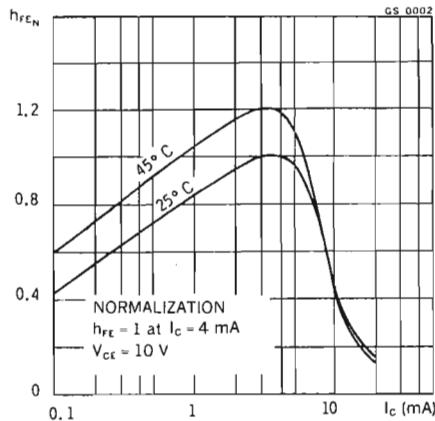
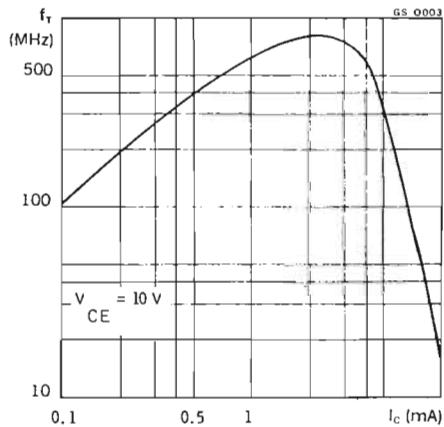
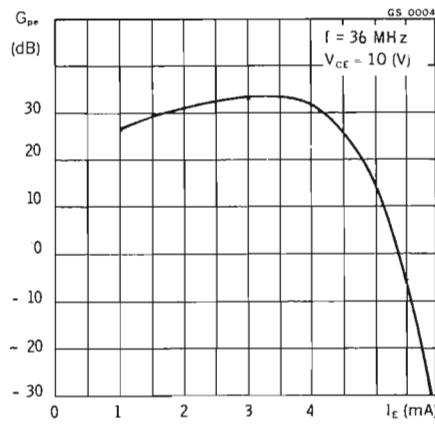
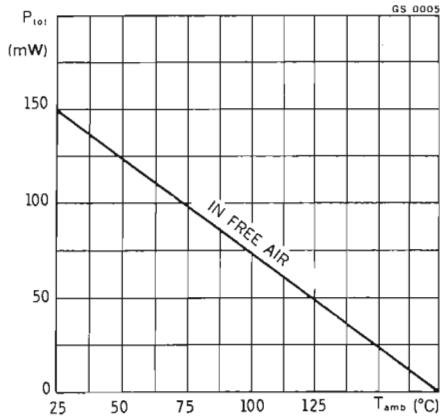
* Pulsed: pulse duration = 300 µs, duty factor = 1%.

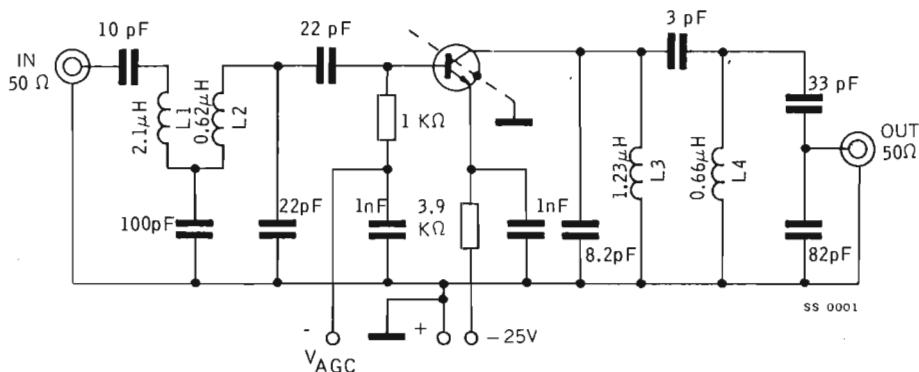
** See test circuit.

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
ΔG_{pe}	Power gain control	V_{EE} = -25 V R_{EE} = 3.9 kΩ f = 36 MHz		60		dB
g_{ie}	Input conductance	I_C = 4 mA V_{CE} = 10 V f = 36 MHz		3.8		mS
b_{ie}	Input susceptance	I_C = 4 mA V_{CE} = 10 V f = 36 MHz		5		mS
g_{fe}	Forward transconductance	I_C = 4 mA V_{CE} = 10 V f = 36 MHz		95		mS
b_{fe}	Forward transusceptance	I_C = 4 mA V_{CE} = 10 V f = 36 MHz		34		mS
g_{oe}	Output conductance	I_C = 4 mA V_{CE} = 10 V f = 36 MHz		62		µS
b_{oe}	Output susceptance	I_C = 4 mA V_{CE} = 10 V f = 36 MHz		270		µS

BF 167

Typical output characteristics

DC normalized current gain

Transition frequency

Power gain

Power rating chart

TEST CIRCUIT

Power gain (f = 36 MHz)

SILICON PLANAR NPN

BF 173

VIDEO IF AMPLIFIER

The BF 173 is a silicon planar epitaxial NPN transistor in a Jedec TO-72 metal case with a very low feedback capacitance. This transistor is intended for use in video IF amplifiers, particularly for the output stage.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	40	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	25	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4	V
I_C	Collector current	25	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25\ °C$	175	mW
	at $T_{case} \leq 25\ °C$	230	mW
T_{stg}	Storage temperature	-55 to 175	°C
T_j	Junction temperature	175	°C

MECHANICAL DATA

Dimensions in mm

TO-72

BF 173

THERMAL DATA

$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	850	°C/W

ELECTRICAL CHARACTERISTICS (T_{case} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = 20 V			20	nA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = 4 V			100	μA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 100 μA	40			V
$V_{(BR)\ CEO}$	Collector-emitter breakdown voltage (I_B = 0)	I_C = 2 mA	25			V
V_{BE}	Base-emitter voltage	I_C = 7 mA V_{CE} = 10 V			0.9	V
f_T	Transition frequency	I_C = 5 mA V_{CE} = 10 V		1000		MHz
$-C_{re}$	Reverse capacitance	I_C = 5 mA V_{CE} = 10 V f = 0.5 MHz		0.23		pF
I_B	Base current	I_C = 7 mA V_{CE} = 10 V		61	185	μA
V_o*	Output voltage	I_C = 7.2 mA V_{CE} = 12 V f = 38.9 MHz	6	7.7		V
G_{tr}	Transducer power gain	I_C = 7.2 mA V_{CE} = 12 V f = 36.4 MHz		26		dB
g_{ie}	Input conductance	I_C = 7 mA V_{CE} = 10 V f = 35 MHz		3		mS
C_{ie}	Input capacitance	I_C = 7 mA V_{CE} = 10 V f = 35 MHz		22		pF

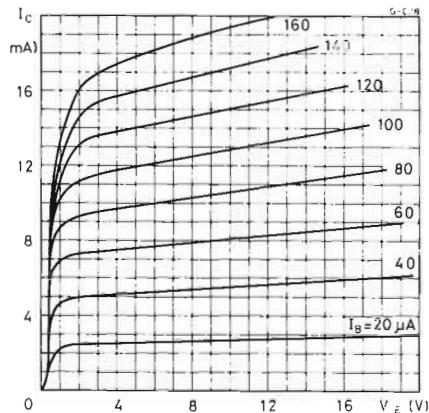
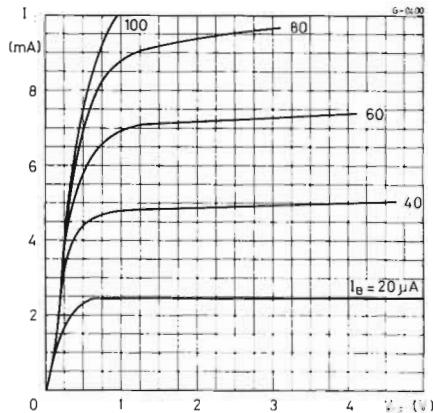
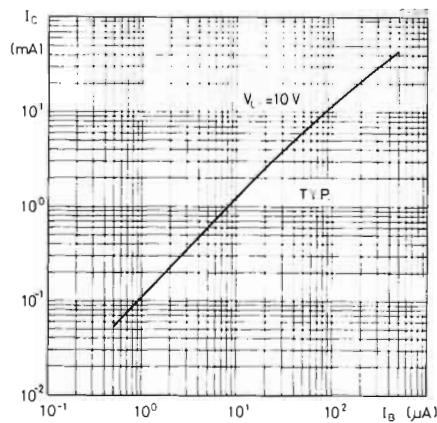
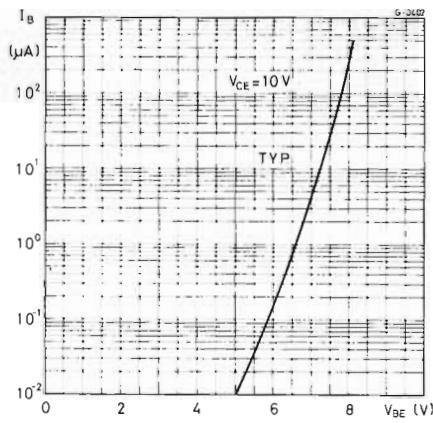
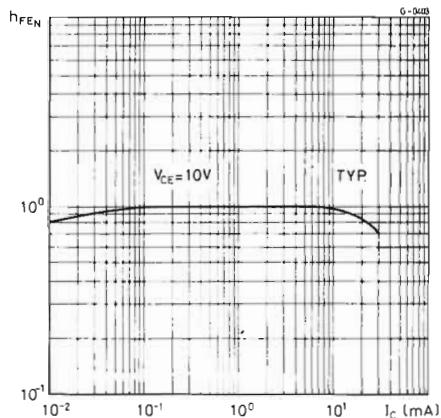
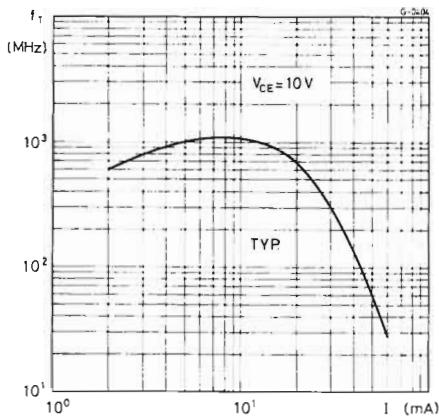
* Voltage across the detector load R_L = 2.7 kΩ for 30% syncronisation pulse compression.

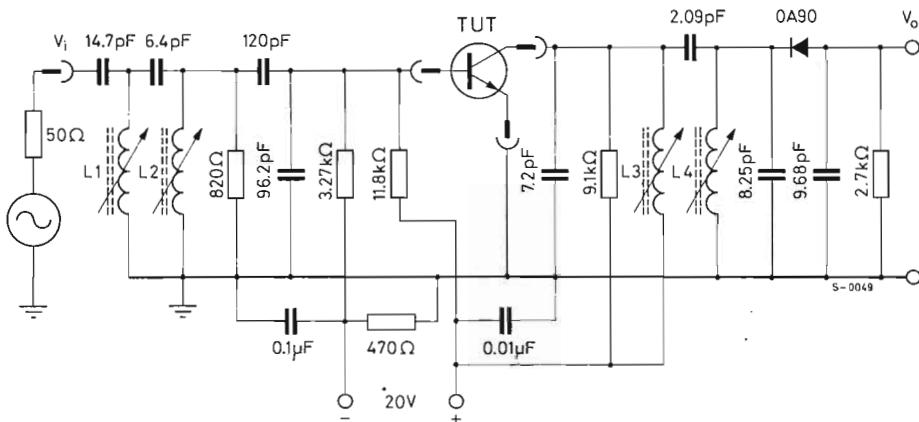
ELECTRICAL CHARACTERISTICS (continued)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$\lvert y_{re}\rvert$	Reverse transadmittance	I_C = 7 mA V_{CE} = 10 V f = 35 MHz		55		μS
φ_{re}	Phase angle of reverse transadmittance	I_C = 7 mA V_{CE} = 10 V f = 35 MHz		267°		—
$\lvert y_{fe}\rvert$	Forward transadmittance	I_C = 7 mA V_{CE} = 10 V f = 35 MHz		165		mS
φ_{fe}	Phase angle of forward transadmittance	I_C = 7 mA V_{CE} = 10 V f = 35 MHz		336°		—
g_{oe}	Output conductance	I_C = 7 mA V_{CE} = 10 V f = 35 MHz		65		μS
C_{oe}	Output capacitance	I_C = 7 mA V_{CE} = 10 V f = 35 MHz		1.9		pF
G_{UM}*	Maximum unilateralized power gain	I_C = 7 mA V_{CE} = 10 V f = 35 MHz		44.5		dB

* $G_{UM} = 10 \log \frac{|y_{fe}|^2}{4 g_{ie} g_{oe}}$

BF 173

Typical output characteristics

Typical output characteristics

Collector characteristic

Input characteristic

DC normalized current gain

Transition frequency

TEST CIRCUIT

G_{tr} test circuit

L_1 = 0.8 μH, 9 turns Ø 0.15 mm. enameled silk-covered copper wire. **L_2** = 0.25 μH, 4 turns Ø 0.15 mm. enameled silk-covered copper wire. **L_3** = 1.7 μH, 12.5 turns Ø 0.15 mm. enameled silk-covered copper wire **L_4** = 1.3 μH, 11 turns Ø 0.15 mm. enameled silk-covered copper wire.

BF 222

SILICON PLANAR NPN

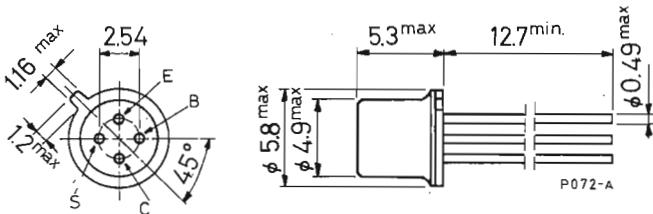
AMPLIFIER AND CONVERTER FOR FM TUNERS

The BF 222 is a silicon planar NPN transistor in a TO-72 metal case. This device is designed for tuners of FM receivers, and features low noise, high gain and excellent forward AGC.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	50	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	40	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4	V
I_C	Collector current	20	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25\,°C$	175	mW
T_{stg}	Storage temperature	-55 to 175	°C
T_j	Junction temperature	175	°C

MECHANICAL DATA

Dimensions in mm

(sim. to **TO-72**)

BF 222

THERMAL DATA

$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	875	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)	V_{CB} = 10 V			1	nA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 50 μA	50			V
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage (I_B = 0)	I_C = 5 mA	40			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = 50 μA	4			V
V_{BE}	Base-emitter voltage	I_C = 2 mA V_{CE} = 7 V		0.74		V
h_{FE}	DC current gain	I_C = 2 mA V_{CE} = 7 V	20	60		—
f_T	Transition frequency	I_C = 2 mA V_{CE} = 7 V		400		MHz
$-C_{re}$	Feedback capacitance	I_C = 2 mA V_{CE} = 7 V f =1 MHz		0.4		pF
NF	Noise figure	I_C = 4 mA V_{CE} = 5 V R_g = 150 Ω f = 100 MHz			5	dB
G_{pe}	Power gain	I_C = 4 mA V_{CE} = 5 V f = 100 MHz		20		dB
ΔG_{pe}	Power gain control	I_E = 9 mA V_{CC} = 7 V R_{DC} = 510 Ω f = 100 MHz		30		dB

* Pulsed: pulse duration = 300 μs, duty factor = 1%.

SILICON PLANAR NPN

BF 233
BF 234

AM MIXER OSCILLATOR, AM-FM IF AMPLIFIER

The BF 233 and BF 234 are silicon planar epitaxial NPN transistors in TO-18 epoxy package. They are intended for use in AM mixer/oscillator stages, IF amplifiers for AM/FM radio receivers and in sound IF stages for TV receivers.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	30	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	30	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4	V
I_C	Collector current	50	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25\ °C$	200	mW
T_{stg}	Storage temperature	-55 to 125	°C
T_j	Junction temperature	125	°C

MECHANICAL DATA

Dimensions in mm

TO-18 epoxy

BF 233
BF 234

THERMAL DATA

$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	500	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)	V_{CB} = 10 V			200	nA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 10 μA	30			V
$V_{CEO\ (sus)}$	Collector-emitter sustaining voltage (I_B = 0)	I_C = 2 mA	30			V
V_{EBO}	Emitter-base voltage (I_C = 0)	I_E = 10 μA	4			V
V_{BE}	Base-emitter voltage	I_C = 1 mA V_{CE} = 10 V	0.64	0.7	0.74	V
h_{FE}	DC current gain	I_C = 1 mA V_{CE} = 10 V				
		for **BF 233** Gr. 2	40	60	70	—
		for **BF 233** Gr. 3	60	80	100	—
		for **BF 233** Gr. 4	90	115	150	—
		for **BF 233** Gr. 5	140	175	220	—
		for **BF 233** Gr. 6	200	245	350	—
		for **BF 234**	90	120	330	—
f_T	Transition frequency	I_C = 1 mA V_{CE} = 10 V	150	500		MHz
$-C_{re}$	Feedback capacitance	I_C = 1 mA V_{CE} = 10 V f = 1 MHz		0.5	1	pF
NF	Noise figure	I_C = 1 mA V_{CE} = 10 V R_g = 300 Ω f = 470 kHz		1.2		dB
NF_C	Conversion noise figure	I_C = 1 mA V_{CE} = 10 V R_g = 500 Ω f = 200 kHz f = 1 MHz		4 3.5		dB dB
G_{pe}	Power gain	I_C =1 mA V_{CE} = 10 V f = 470 kHz		40		dB

BF 233
BF 234

ELECTRICAL CHARACTERISTICS (continued)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
g_{ie}	Input conductance	I_C = 1 mA V_{CE} = 10 V				
		f = 470 kHz		0.24		mS
		f = 5.5 MHz		0.28		mS
		f = 10.7 MHz		0.30		mS
b_{ie}	Input susceptance	I_C = 1 mA V_{CE} = 10 V				
		f = 470 kHz		22		µS
		f = 5.5 MHz		260		µS
		f = 10.7 MHz		500		µS
b_{re}	Reverse transusceptance	I_C = 1 mA V_{CE} = 10 V				
		f = 470 kHz		-1.6		µS
		f = 5.5 MHz		-17		µS
		f = 10.7 MHz		-34		µS
φ_{re}	Phase angle of reverse transadmittance	I_C = 1 mA V_{CE} = 10 V				
		f = 470 kHz		-90°		—
		f = 5.5 MHz		-90°		—
		f = 10.7 MHz		-90°		—
g_{fe}	Forward transconductance	I_C = 1 mA V_{CE} = 10 V				
		f = 470 kHz		35		mS
		f = 5.5 MHz		35		mS
		f = 10.7 MHz		35		mS
b_{fe}	Forward transusceptance	I_C = 1 mA V_{CE} = 10 V				
		f = 470 kHz		0		mS
		f = 5.5 MHz		-0.5		mS
		f = 10.7 MHz		-1		mS
g_{oe}	Output conductance	I_C = 1 mA V_{CE} = 10 V				
		f = 470 kHz		7		µS
		f = 5.5 MHz		9		µS
		f = 10.7 MHz		11		µS
b_{oe}	Output susceptance	I_C = 1 mA V_{CE} = 10 V				
		f = 470 kHz		4.4		µS
		f = 5.5 MHz		52		µS
		f = 10.7 MHz		100		µS

SILICON PLANAR NPN

BF 257
BF 258
BF 259

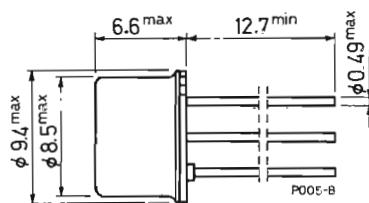
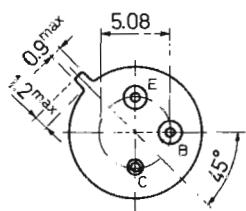
HIGH VOLTAGE VIDEO AMPLIFIERS

The BF 257, BF 258 and BF 259 are silicon planar epitaxial NPN transistors in TO-39 metal case. They are particularly designed for video output stages in CTV and MTV sets, class A audio output stages and drivers for horizontal deflection circuits.

ABSOLUTE MAXIMUM RATINGS

		BF 257	BF 258	BF 259
V_{CBO}	Collector-base voltage ($I_E = 0$)	160 V	250 V	300 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	160 V	250 V	300 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	5 V		
I_C	Collector current	100 mA		
I_{CM}	Collector peak current	200 mA		
P_{tot}	Total power dissipation at $T_{case} \leq 50$ °C	5 W		
T_{stg}	Storage temperature	-55 to 200 °C		
T_j	Junction temperature	200 °C		

MECHANICAL DATA

Dimensions in mm

(sim. to **TO-39**)

BF 257
BF 258
BF 259

THERMAL DATA

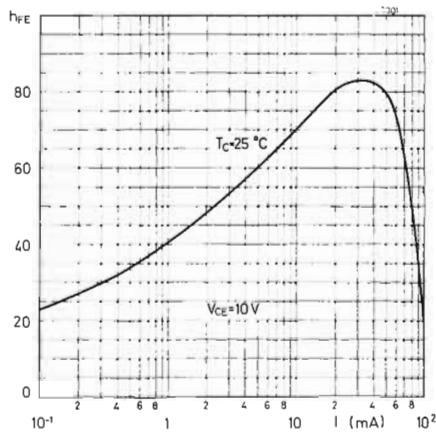
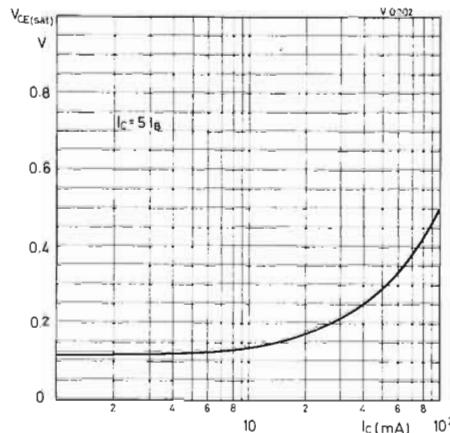
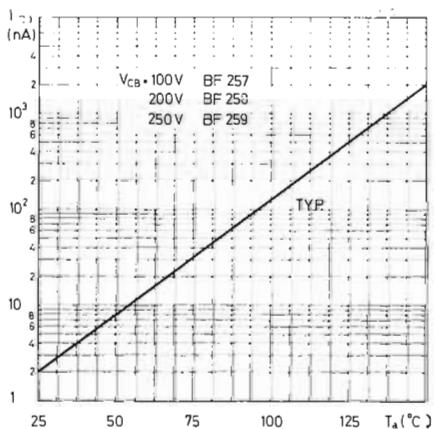
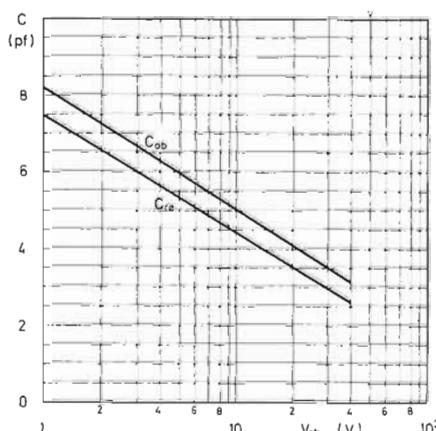
$R_{th\ j-case}$	Thermal resistance junction-case	max	30	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	175	°C/W

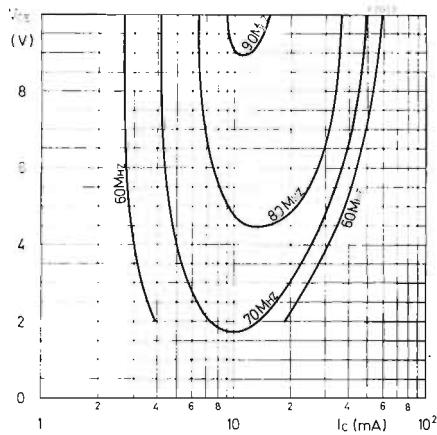
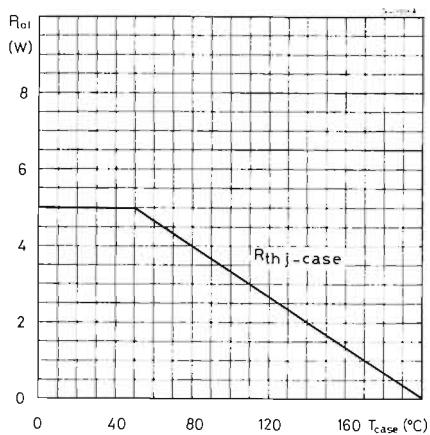
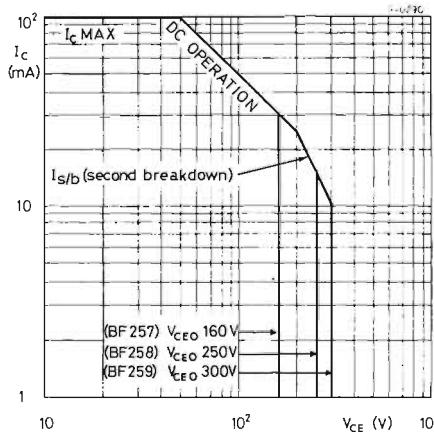
ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	for **BF 257** V_{CB} = 100 V			50	nA
		for **BF 258** V_{CB} = 200 V			50	nA
		for **BF 259** V_{CB} = 250 V			50	nA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage ($I_E = 0$)	I_C = 100 μA				
		for **BF 257**	160			V
		for **BF 258**	250			V
		for **BF 259**	300			V
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage ($I_B = 0$)	I_C = 10 mA				
		for **BF 257**	160			V
		for **BF 258**	250			V
		for **BF 259**	300			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	I_E = 100 μA	5			V
$V_{CE\ (sat)}$*	Collector-emitter saturation voltage	I_C = 30 mA I_B = 6 mA			1	V
h_{FE}*	DC current gain	I_C = 30 mA V_{CE} = 10 V	25			—
f_T	Transition frequency	I_C = 15 mA V_{CE} = 10 V		90		MHz
$-C_{re}$	Feedback capacitance	I_C = 0 V_{CE} = 30 V, f = 1 MHz		3		pF

* Pulsed: pulse duration = 300 μs, duty factor = 1%.

BF 257
BF 258
BF 259

DC current gain

Collector-emitter saturation voltage

Collector cutoff current

Collector-base capacitance

BF 257
BF 258
BF 259

Transition frequency

Power rating chart

Safe operating area

BF 260

SILICON PLANAR NPN

AGC VHF AMPLIFIER

The BF 260 is a silicon planar NPN transistor in a Jedec TO-72 metal case, with a very low feedback capacitance. It is intended primarily for use as RF amplifier in television tuners up to 260 MHz.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	45	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	30	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4	V
I_C	Collector current	50	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25\ °C$	150	mW
	at $T_{case} \leq 25\ °C$	230	mW
T_{stg}	Storage temperature	-65 to 175	°C
T_j	Junction temperature	175	C

MECHANICAL DATA

Dimensions in mm

TO-72

BF 260

THERMAL DATA

$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	1000	°C/W

ELECTRICAL CHARACTERISTICS (T_{case} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	$V_{CB} = 1$ V			20	nA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage ($I_E = 0$)	$I_C = 1\ \mu A$	45			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 10\ \mu A$	4			V
V_{BE}	Base-emitter voltage	$I_C = 3$ mA $V_{CE} = 10$ V		0.68		V
h_{FE}	DC current gain	$I_C = 1$ mA $V_{CE} = 6$ V		70		—
f_T	Transition frequency	$I_C = 3$ mA $V_{CE} = 10$ V f = 100 MHz		800		MHz
$-C_{re}$	Reverse capacitance	$I_C = 3$ mA $V_{CE} = 10$ V f = 0.5 MHz		0.16		pF
NF	Noise figure	$I_C = 3$ mA $V_{CE} = 10$ V			4	dB
G_{pe}	Power gain	$I_C = 3$ mA $V_{CE} = 10$ V		21		dB
ΔG_{pe}	Power gain control	$\Delta I_C = 8$ mA $V_{CE} = 12$ V $R_E + R_L = 680\ \Omega$ f = 200 MHz		30		dB
g_{ie}	Input conductance	$I_C = 2$ mA $V_{CE} = 10$ V f = 50 MHz		1.5		mS
b_{ie}	Input susceptance	$I_C = 2$ mA $V_{CE} = 10$ V f = 50 MHz		3.6		mS

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min. Typ. Max.	Unit
$\|y_{re}\|$	Reverse transadmittance	I_C = 2 mA V_{CE} = 10 V f = 50 MHz	50	μS
φ_{re}	Phase angle of reverse transadmittance	I_C = 2 mA V_{CE} = 10 V f = 50 MHz	270°	—
$\|y_{fe}\|$	Forward transadmittance	I_C = 2 mA V_{CE} = 10 V f = 50 MHz	66	mS
φ_{fe}	Phase angle of forward transadmittance	I_C = 2 mA V_{CE} = 10 V f = 50 MHz	340°	—
g_{oe}	Output conductance	I_C = 2 mA V_{CE} = 10 V f = 50 MHz	15	μS
b_{oe}	Output susceptance	I_C = 2 mA V_{CE} = 10 V f = 50 MHz	0.34	mS
g_{ie}	Input conductance	I_C = 2 mA V_{CE} = 10 V f = 100 MHz	3.2	mS
b_{ie}	Input susceptance	I_C = 2 mA V_{CE} = 10 V f = 100 MHz	6.5	mS
$\|y_{re}\|$	Reverse transadmittance	I_C = 2 mA V_{CE} = 10 V f = 100 MHz	94	μS
φ_{re}	Phase angle of reverse transadmittance	I_C = 2 mA V_{CE} = 10 V f = 100 MHz	270°	—
$\|y_{fe}\|$	Forward transadmittance	I_C = 2 mA V_{CE} = 10 V f = 100 MHz	65	mS
φ_{fe}	Phase angle of forward transadmittance	I_C = 2 mA V_{CE} = 10 V f = 100 MHz	335°	—
g_{oe}	Output conductance	I_C = 2 mA V_{CE} = 10 V f = 100 MHz	30	μS
b_{oe}	Output susceptance	I_C = 2 mA V_{CE} = 10 V f = 100 MHz	0.9	mS

BF 260

ELECTRICAL CHARACTERISTICS (continued)

	Parameter	Test conditions	Min. Typ. Max.	Unit
g_{ie}	Input conductance	I_C = 2 mA V_{CE} = 10 V f = 200 MHz	8	mS
b_{ie}	Input susceptance	I_C = 2 mA V_{CE} = 10 V f = 200 MHz	10	mS
$\lvert y_{re} \rvert$	Reverse transadmittance	I_C = 2 mA V_{CE} = 10 V f = 200 MHz	170	µS
φ_{re}	Phase angle of reverse transadmittance	I_C = 2 mA V_{CE} = 10 V f = 200 MHz	270°	—
$\lvert y_{fe} \rvert$	Forward transadmittance	I_C = 2 mA V_{CE} = 10 V f = 200 MHz	62	mS
φ_{fe}	Phase angle of forward transadmittance	I_C = 2 mA V_{CE} = 10 V f = 200 MHz	318°	—
g_{oe}	Output conductance	I_C = 2 mA V_{CE} = 10 V f = 200 MHz	130	µS
b_{oe}	Output susceptance	I_C = 2 mA V_{CE} = 10 V f = 200 MHz	1.7	mS
g_{ie}	Input conductance	I_C = 3 mA V_{CE} = 10 V f = 50 MHz	2.4	mS
b_{ie}	Input susceptance	I_C = 3 mA V_{CE} = 10 V f = 50 MHz	5	mS
$\lvert y_{re} \rvert$	Reverse transadmittance	I_C = 3 mA V_{CE} = 10 V f = 100 MHz	50	µS
φ_{re}	Phase angle of reverse transadmittance	I_C = 3 mA V_{CE} = 10 V f = 50 MHz	270°	—
$\lvert y_{fe} \rvert$	Forward transadmittance	I_C = 3 mA V_{CE} = 10 V f = 50 MHz	92	mS
φ_{fe}	Phase angle of forward transadmittance	I_C = 3 mA V_{CE} = 10 V f = 50 MHz	343°	—

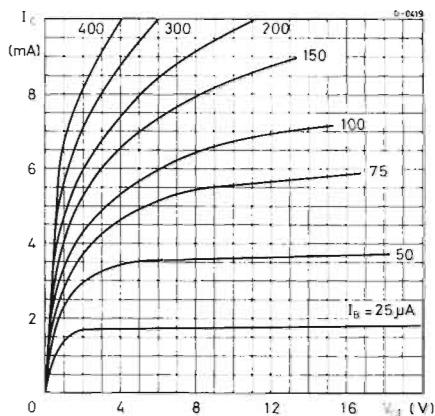
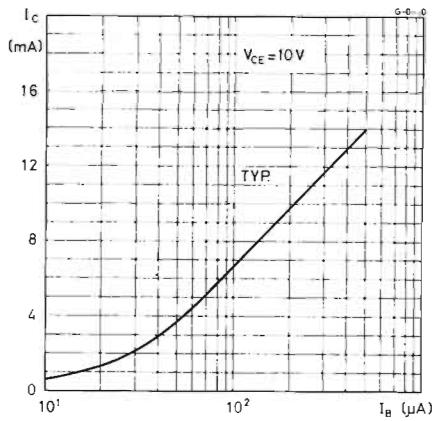
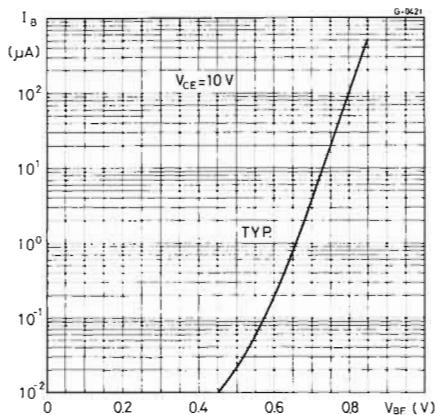
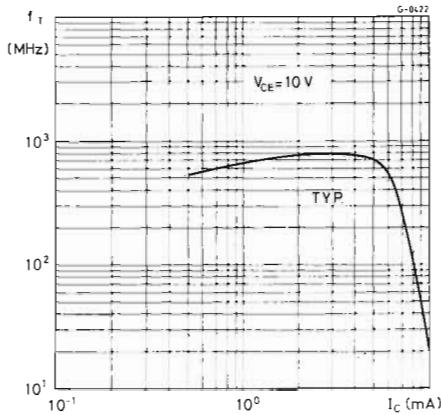
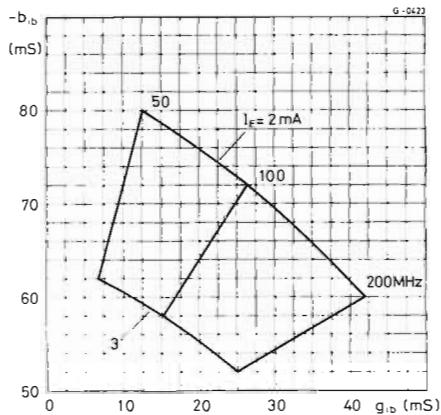
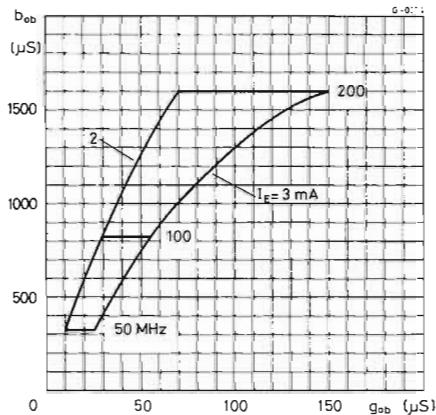
ELECTRICAL CHARACTERISTICS (continued)

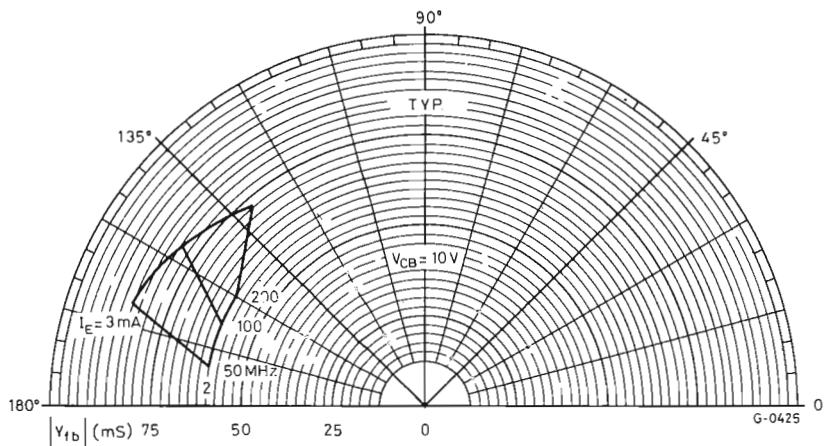
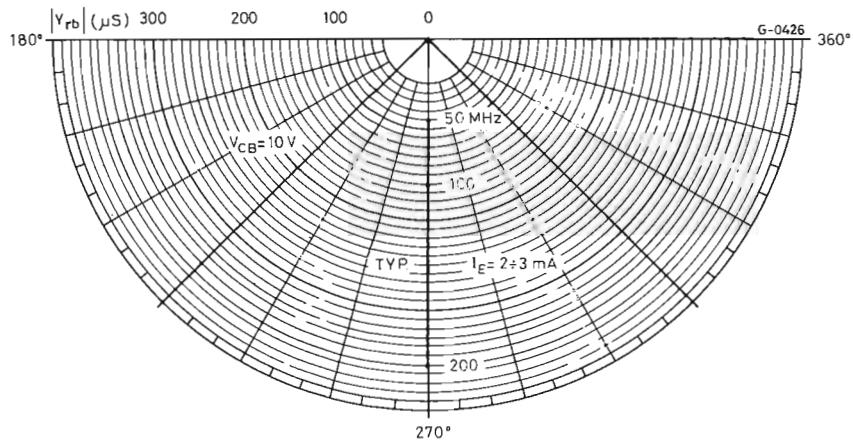
	Parameter	Test conditions	Min. Typ. Max.	Unit
g_{oe}	Output conductance	I_C = 3 mA V_{CE} = 10 V f = 50 MHz	20	µS
b_{oe}	Output susceptance	I_C = 3 mA V_{CE} = 10 V f = 100 MHz	0.34	mS
g_{ie}	Input conductance	I_C = 3 mA V_{CE} = 10 V f = 100 MHz	4.5	mS
b_{ie}	Input susceptance	I_C = 3 mA V_{CE} = 10 V f = 50 MHz	7.2	mS
$\|y_{re}\|$	Reverse transadmittance	I_C = 3 mA V_{CE} = 10 V f = 50 MHz	94	µS
φ_{re}	Phase angle of reverse transadmittance	I_C = 3 mA V_{CE} = 10 V f = 100 MHz	270°	—
$\|y_{fe}\|$	Forward transadmittance	I_C = 3 mA V_{CE} = 10 V f = 100 MHz	87	mS
φ_{fe}	Phase angle of forward transadmittance	I_C = 3 mA V_{CE} = 10 V f = 100 MHz	333°	—
g_{oe}	Output conductance	I_C = 3 mA V_{CE} = 10 V f = 100 MHz	50	µS
b_{oe}	Output susceptance	I_C = 3 mA V_{CE} = 10 V f = 100 MHz	0.9	mS
g_{ie}	Input conductance	I_C = 3 mA V_{CE} = 10 V f = 200 MHz	9	mS
b_{ie}	Input susceptance	I_C = 3 mA V_{CE} = 10 V f = 200 MHz	11.5	mS
$\|y_{re}\|$	Reverse transadmittance	I_C = 3 mA V_{CE} = 10 V f = 200 MHz	170	µS
φ_{re}	Phase angle of reverse transadmittance	I_C = 3 mA V_{CE} = 10 V f = 200 MHz	270°	—
$\|y_{fe}\|$	Forward transadmittance	I_C = 3 mA V_{CE} = 10 V f = 200 MHz	80	mS

BF 260

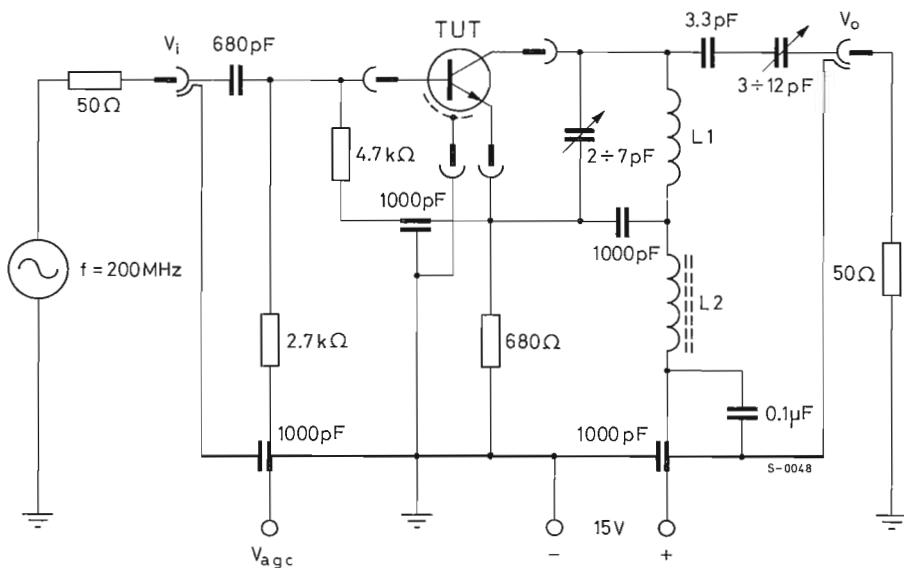
ELECTRICAL CHARACTERISTICS (continued)

	Parameter	Test conditions	Min. Typ. Max.	Unit
φ_{fe}	Phase angle of forward transadmittance	I_C = 3 mA V_{CE} = 10 V f = 200 MHz	310°	—
g_{oe}	Output conductance	I_C = 3 mA V_{CE} = 10 V f = 200 MHz	180	µS
b_{oe}	Output susceptance	I_C = 3 mA V_{CE} = 10 V f = 200 MHz	1.7	mS

Typical output characteristics

Collector characteristic

Input characteristic

Transition frequency

Typical input admittance *

Typical output admittance *

* Lead length = 3 mm.

Forward transadmittance *

Reverse transadmittance *

* Lead length = 3 mm.

TEST CIRCUIT

200 MHz G_{pb}, AGC, and NF test circuit

BF 271

SILICON PLANAR NPN

VIDEO IF AMPLIFIER

The BF 271 is a silicon planar NPN transistor in a TO-72 metal case. This device has been specifically designed for use in output stages of IF vision amplifiers. It features high power gain, low feedback capacitance and excellent linearity.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	30	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	25	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4	V
I_C	Collector current	25	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25\ °C$	250	mW
	at $T_{case} \leq 25\ °C$	430	mW
T_{stg}	Storage temperature	-55 to 200	°C
T_j	Junction temperature	200	°C

MECHANICAL DATA

Dimensions in mm

(sim. to **TO-72**)

BF 271

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	400	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	700	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = 10 V		100		nA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 10 μA	30			V
$V_{(BR)\ CEO}$	Collector-emitter breakdown voltage (I_B = 0)	I_C = 1 mA	25			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = 10 μA	4			V
V_{BE}	Base-emitter voltage	I_C = 10 mA V_{CE} = 5 V		780		mV
h_{FE}*	DC current gain	I_C = 1 mA V_{CE} = 10 V I_C = 10 mA V_{CE} = 10 V	 30	55 75		— —
f_T	Transition frequency	I_C = 10 mA V_{CE} = 10 V		900		MHz
$-C_{re}$	Feedback capacitance	I_C = 0 V_{CE} = 10 V f = 1 MHz		0.22		pF
G_{pe}	Power gain	I_C = 10 mA V_{CE} = 10 V f = 36 MHz	24	27		dB
g_{ie}	Input conductance	I_C = 10 mA V_{CE} = 10 V f = 36 MHz		4.8		mS

* Pulsed: pulse duration = 300 μs; duty factor = 1%.

ELECTRICAL CHARACTERISTICS (continued)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
b_{ie}	Input susceptance	I_C = 10 mA V_{CE} = 10 V f = 36 MHz		5.2		mS
g_{fe}	Forward transconductance	I_C = 10 mA V_{CE} = 10 V f = 36 MHz		200		mS
b_{fe}	Forward transusceptance	I_C = 10 mA V_{CE} = 10 V f = 36 MHz		80		mS
g_{oe}	Output conductance	I_C = 10 mA V_{CE} = 10 V f = 36 MHz		80		µS
b_{oe}	Output susceptance	I_C = 10 mA V_{CE} = 10 V f = 36 MHz		380		µS

SILICON PLANAR PNP

BF 272A

UHF-VHF AGC AMPLIFIER

The BF 272A is a silicon planar epitaxial PNP transistor in a TO-72 metal case. This device is specifically designed for RF stages of UHF-VHF tuners. It features high gain, low feedback capacitance and very low noise figure.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-40	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-35	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-3	V
I_C	Collector current	-20	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25\ °C$	200	mW
T_{stg}	Storage temperature	-55 to 200	°C
T_j	Junction temperature	200	°C

MECHANICAL DATA

Dimensions in mm

(sim. to **TO-72**)

BF 272A

THERMAL DATA

$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	875	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

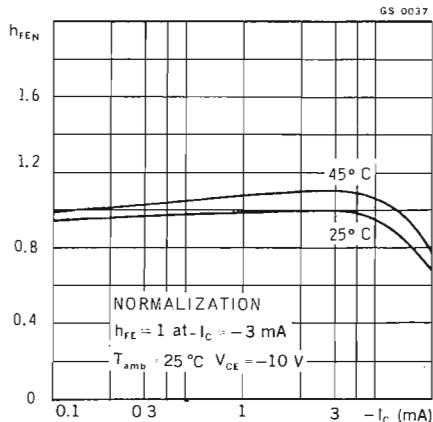
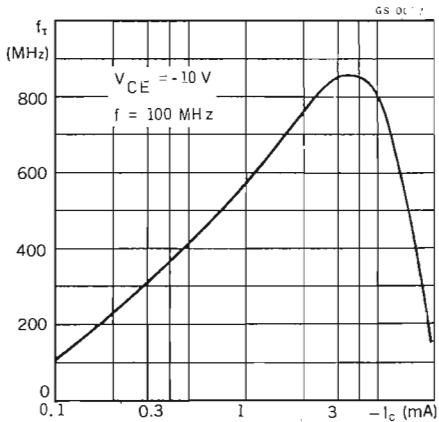
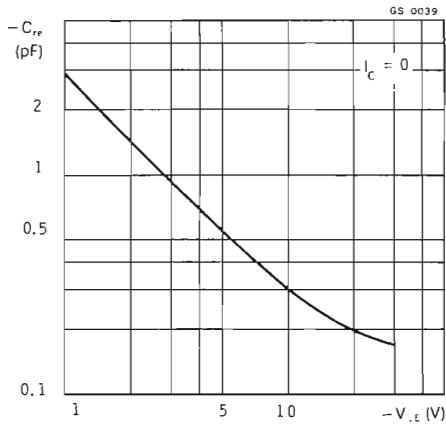
	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)	V_{CB} = -20 V			-100	nA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = -10 µA	-40			V
$V_{(BR)\ CEO}$	Collector-emitter breakdown voltage (I_B = 0)	I_C = -3 mA	-35			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = -10 µA	-3			V
V_{BE}	Base-emitter voltage	I_C = -3 mA V_{CE} = -10 V		-0.75		V
h_{FE}	DC current gain	I_C = -3 mA V_{CE} = -10 V	25	50		—
f_T	Transition frequency	I_C = -3 mA V_{CE} = -10 V	700	850		MHz
$-C_{re}$	Feedback capacitance	I_C = 0 V_{CE} = -10 V f = 1 MHz		0.3		pF
C_{rb}	Feedback capacitance	I_C = 0 V_{CB} = -10 V f = 1 MHz		0.05	0.09	pF
NF*	Noise figure	I_C = -3 mA V_{CB} = -10 V R_g = 50 Ω f = 800 MHz		3.5	5.5	dB
		I_C = -3 mA V_{CB} = -10 V R_g = 50 Ω f = 200 MHz		2.5		dB
G_{pb}*	Power gain	I_C = -3 mA V_{CB} = -10 V R_L = 2 kΩ f = 800 MHz	12	15		dB
		I_C = -3 mA V_{CB} = -10 V R_L = 2 kΩ f = 200 MHz		19		dB

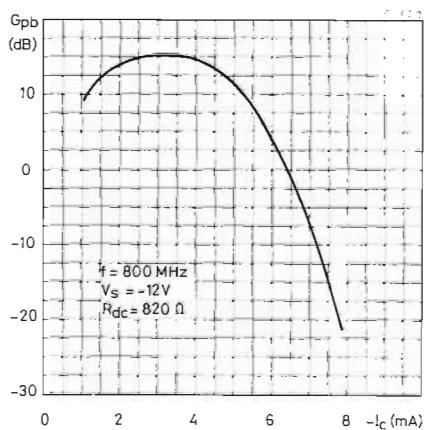
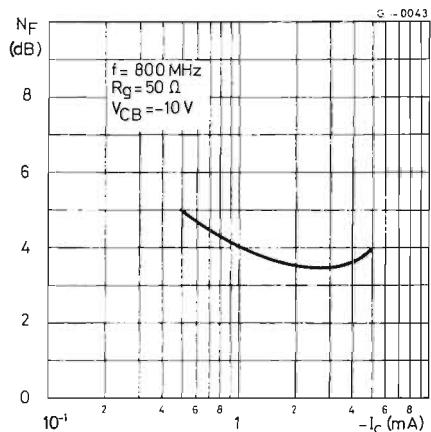
ELECTRICAL CHARACTERISTICS (continued)

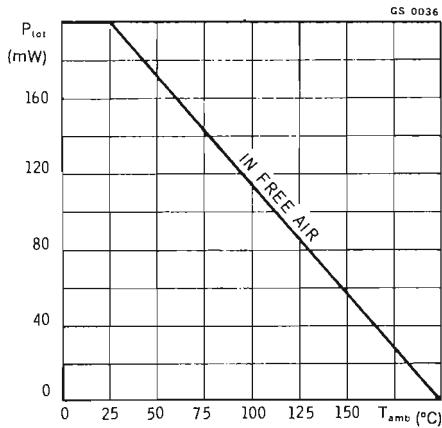
Parameter		Test conditions	Min.	Typ.	Max.	Unit
$I_{C\,(AGC)}$*	Collector current for $\Delta G_{pb} = 30$ dB	f = 800 MHz $V_{CC} = 12$ V	6.6		8	mA
g_{ib}	Input conductance	I_C = -3 mA V_{CB} = -10 V f = 800 MHz		7		mS
		I_C = -3 mA V_{CB} = -10 V f = 200 MHz		60		mS
b_{ib}	Input susceptance	I_C = -3 mA V_{CB} = -10 V f = 800 MHz		-26		mS
		I_C = -3 mA V_{CB} = -10 V f = 200 MHz		-36		mS
g_{ob}	Output conductance	I_C = -3 mA V_{CB} = -10 V f = 800 MHz		0.77		mS
		I_C = -3 mA V_{CB} = -10 V f = 200 MHz		0.1		mS
b_{ob}	Output susceptance	I_C = -3 mA V_{CB} = -10 V f = 800 MHz		5		mS
		I_C = -3 mA V_{CB} = -10 V f = 200 MHz		1.3		mS
g_{fb}	Forward transconductance	I_C = -3 mA V_{CB} = -10 V f = 800 MHz		11		mS
		I_C = -3 mA V_{CB} = -10 V f = 200 MHz		-51		mS
b_{fb}	Forward transusceptance	I_C = -3 mA V_{CB} = -10 V f = 800 MHz		23		mS
		I_C = -3 mA V_{CB} = -10 V f = 200 MHz		45		mS
g_{rb}	Reverse transconductance	I_C = -3 mA V_{CB} = -10 V f = 800 MHz		-0.1		mS
		I_C = -3 mA V_{CB} = -10 V f = 200 MHz		-0.02		mS
b_{rb}	Reverse transusceptance	I_C = -3 mA V_{CB} = -10 V f = 800 MHz		-0.35		mS
		I_C = -3 mA V_{CB} = -10 V f = 200 MHz		-0.1		mS

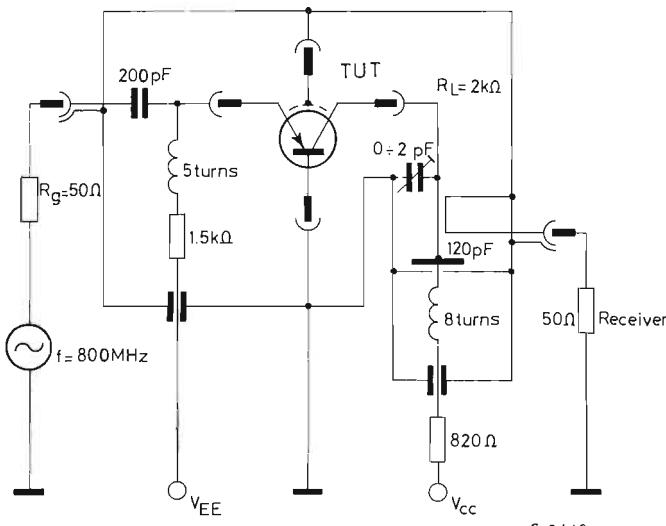
* See TEST CIRCUIT

BF 272A

Normalized DC current gain

Transition frequency

Feedback capacitance

Power gain

Noise figure

Power rating chart

TEST CIRCUIT

Power gain, AGC and noise figure (f = 800 MHz)

SILICON PLANAR NPN

BF 273

AM CONVERTER AND AM-FM IF AMPLIFIER

The BF 273 is a silicon planar NPN transistor in a TO-18 epoxy package, intended for use in AM converters and IF amplifiers for AM and AM/FM radios.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	25	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	20	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4	V
I_C	Collector current	30	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25$ °C	200	mW
T_{stg}	Storage temperature	-55 to 125	°C
T_j	Junction temperature	125	°C

MECHANICAL DATA

Dimensions in mm

TO-18 epoxy

BF 273

THERMAL DATA

$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	500	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = 10 V			100	nA
		V_{CE} = 10 V T_{amb} = 100°C			50	μA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 10 μA	25			V
$V_{(BR)\ CEO}$	Collector-emitter breakdown voltage (I_B = 0)	I_C = 1 mA	20			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = 10 μA	4			V
V_{BE}	Base-emitter voltage	I_C = 1 mA V_{CE} = 10 V		0.70		V
h_{FE}	DC current gain	I_C = 1 mA V_{CE} = 10 V				
		for BF 273	35			—
		for BF 273 Gr. C	70		120	—
		for BF 273 Gr. D	35		75	—
f_T	Transition frequency	I_C = 1 mA V_{CE} = 10 V	400	600		MHz
NF	Noise figure	I_C = 1 mA V_{CE} = 10 V, R_g = 400 Ω, f = 100 MHz		2		dB
$-C_{re}$	Feedback capacitance	I_C = 0 V_{CE} = 10 V, f = 1 MHz		0.41		pF
G_{pe}	Power gain	I_C = 1 mA V_{CE} = 10 V, f = 470 kHz		40		dB
		I_C = 1 mA V_{CE} = 10 V, f = 10.7 MHz		30		dB
		I_C = 1 mA V_{CE} = 10 V, f = 100 MHz		21		dB

ELECTRICAL CHARACTERISTICS (continued)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
g_{ie}	Input conductance	I_C = 1 mA V_{CE} = 10 V f = 470 kHz		240		μS
		I_C = 1 mA V_{CE} = 10 V f = 10.7 MHz		300		μS
		I_C = 1 mA V_{CE} = 10 V f = 100 MHz		900		μS
b_{ie}	Input susceptance	I_C = 1 mA V_{CE} = 10 V f = 470 kHz		22		μS
		I_C = 1 mA V_{CE} = 10 V f = 10.7 MHz		500		μS
		I_C = 1 mA V_{CE} = 10 V f = 100 MHz		4.8		mS
b_{re}	Reverse transusceptance	I_C = 1 mA V_{CE} = 10 V f = 470 kHz		-1.2		μS
		I_C = 1 mA V_{CE} = 10 V f = 10.7 MHz		-27.6		μS
		I_C = 1 mA V_{CE} = 10 V f = 100 MHz		-260		μS
φ_{re}	Reverse transadmittance phase	I_C = 1 mA V_{CE} = 10 V f = 470 kHz		-90°		—
		I_C = 1 mA V_{CE} = 10 V f = 10.7 MHz		-90°		—
		I_C = 1 mA V_{CE} = 10 V f = 100 MHz		-90°		—
g_{fe}	Forward transconductance	I_C = 1 mA V_{CE} = 10 V f = 470 kHz		35		mS
		I_C = 1 mA V_{CE} = 10 V f = 10.7 MHz		35		mS
		I_C = 1 mA V_{CE} = 10 V f = 100 MHz		32		mS
b_{fe}	Forward transusceptance	I_C = 1 mA V_{CE} = 10 V f = 10.7 MHz		-1		mS
		I_C = 1 mA V_{CE} = 10 V f = 100 MHz		-9		mS

BF 273

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
g_{oe}	Output conductance	I_C = 1 mA V_{CE} = 10 V f = 470 kHz		7		μS
		I_C = 1 mA V_{CE} = 10 V f = 10.7 MHz		11		μS
		I_C = 1 mA V_{CE} = 10 V f = 100 MHz		75		μS
b_{oe}	Output susceptance	I_C = 1 mA V_{CE} = 10 V f = 470 kHz		4.4		μS
		I_C = 1 mA V_{CE} = 10 V f = 10.7 MHz		100		μS
		I_C = 1 mA V_{CE} = 10 V f = 100 MHz		940		μS

SILICON PLANAR NPN

BF 274

GAIN CONTROLLED AM-FM IF AMPLIFIER

The BF 274 is a silicon planar NPN transistor in a TO-18 epoxy package, primarily intended for use in the gain controlled IF stages of AM and AM/FM radio receivers.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	25	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	20	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4	V
I_C	Collector current	30	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25\ °C$	200	mW
T_{stg}	Storage temperature	-55 to 125	°C
T_j	Junction temperature	125	°C

MECHANICAL DATA

Dimensions in mm

TO-18 epoxy

4/73

BF 274

THERMAL DATA

$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	500	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = 10 V V_{CE} = 10 V T_{amb} = 100°C			100 50	nA μA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 10 μA	25			V
$V_{(BR)\ CEO}$	Collector-emitter breakdown voltage (I_B = 0)	I_C = 1 mA	20			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = 10 μA	4			V
V_{BE}	Base-emitter voltage	I_C = 1 mA V_{CE} = 10 V		0.70		V
h_{FE}	DC current gain	I_C = 1 mA V_{CE} = 10 V for BF 274 for BF 274 Gr. B for BF 274 Gr. C	 70 100 70		 250 120	 — — —
f_T	Transition frequency	I_C = 1 mA V_{CE} = 10 V	400	700		MHz
$-C_{re}$	Feedback capacitance	I_C = 0 V_{CE} = 10 V f = 1 MHz		0.41		pF
G_{pe}	Power gain	I_C = 1 mA V_{CE} = 10 V f = 470 kHz I_C = 1 mA V_{CE} = 10 V f = 10.7 MHz		 40 30		 dB dB
ΔG_{pe}	Power gain control	I_C = 100 μA V_{CE} = 10 V f =470 kHz		20		dB

SILICON PLANAR NPN

BF 287

AM MIXER-OSCILLATOR AND AM-FM AMPLIFIER

The BF 287 is a silcon planar NPN transistor in a TO-72 metal case. It is primarily intended for use in the AM mixer-oscillator stage and as IF amplifier of AM-FM radios.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	40	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	40	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4	V
I_C	Collector current	20	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25$ °C	250	mW
	at $T_{case} \leq 45$ °C	220	mW
T_{stg}	Storage temperature	-55 to 200	°C
T_j	Junction temperature	200	°C

MECHANICAL DATA

Dimensions in mm

(sim. to **TO-72**)

BF 287

THERMAL DATA

$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	700	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = 10 V			100	nA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 10 µA	40			V
$V_{CEO\ (sus)}$	Collector-emitter sustaining voltage (I_B = 0)	I_C = 5 mA	40			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = 100 µA	4			V
V_{BE}	Base-emitter voltage	I_C = 1 mA V_{CE} = 7 V I_C = 2 mA V_{CE} = 10 V		710 740		mV mV
h_{FE}	DC current gain	I_C = 1 mA V_{CE} = 7 V I_C = 2 mA V_{CE} = 10 V	30 40	50 60		— —
f_T	Transition frequency	I_C = 1 mA V_{CE} = 7 V f = 100 MHz I_C = 2 mA V_{CE} = 10 V f = 100 MHz		600 700		MHz MHz
G_{pe}	Power gain	I_C = 1 mA V_{CE} = 7 V f = 470 kHz f = 10.7 MHz I_C = 2 mA V_{CE} = 10 V f = 5.5 MHz	42 18 25	45 22 29		dB dB dB
g_{ie}	Input conductance	I_C = 1 mA V_{CE} = 7 V f = 470 kHz f = 10.7 MHz		0.17 0.25		mS mS
b_{ie}	Input susceptance	I_C = 1 mA V_{CE} = 7 V f = 470 kHz f = 10.7 MHz		24 0.52		µS mS

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
g_{fe}	Forward transconductance	I_C = 1 mA V_{CE} = 7 V				
		f = 470 kHz		35		mS
		f = 10.7 MHz		35		mS
$-b_{fe}$	Forward transusceptance	I_C = 1 mA V_{CE} = 7 V				
		f = 470 kHz		40		μS
		f = 10.7 MHz		0.96		mS
g_{oe}	Output conductance	I_C = 1 mA V_{CE} = 7 V				
		f = 470 kHz		6		μS
		f = 10.7 MHz		11		μS
b_{oe}	Output susceptance	I_C = 1 mA V_{CE} = 7 V				
		f = 470 kHz		4.5		μS
		f = 10.7 MHz		100		μS

SILICON PLANAR NPN

BF 288

GAIN CONTROLLED AM-FM IF AMPLIFIER

The BF 288 is a silicon planar NPN transistor in a TO-72 metal case. It is primarily intended for use in the gain controlled IF stages of AM and AM/FM radio receivers.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	40	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	40	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4	V
I_C	Collector current	20	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25$ °C	250	mW
	at $T_{amb} \leq 45$ °C	220	mW
T_{stg}	Storage temperature	-55 to 200	°C
T_j	Junction temperature	200	°C

MECHANICAL DATA

Dimensions in mm

(sim. to **TO-72**)

BF 288

THERMAL DATA

$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	700	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = 7 V			100	nA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 10 µA	40			V
$V_{CEO\ (sus)}$	Collector-emitter sustaining voltage (I_B = 0)	I_C = 5 mA	40			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = 100 µA	4			V
V_{BE}	Base-emitter voltage	I_C = 1 mA V_{CE} = 7 V		740		mV
h_{FE}	DC current gain	I_C = 1 mA V_{CE} = 7 V	65	90		—
f_T	Transition frequency	I_C = 1 mA V_{CE} = 7 V		500		MHz
$-C_{re}$	Feedback capacitance	V_{CE} = 7 V f = 1 MHz		0.24		pF
G_{pe}	Power gain	I_C = 1 mA V_{CE} = 7 V f = 470 kHz f = 10.7 MHz	 42 18	 45 22		 dB dB
g_{ie}	Input conductance	I_C = 1 mA V_{CE} = 7 V f = 470 kHz f = 10.7 MHz		 0.17 0.25		 mS mS
b_{ie}	Input susceptance	I_C = 1 mA V_{CE} = 7 V f = 470 kHz f = 10.7 MHz		 24 0.52		 µS mS
g_{fe}	Forward transconductance	I_C = 1 mA V_{CE} = 7 V f = 470 kHz f = 10.7 MHz		 35 35		 mS mS

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
$-b_{fe}$	Forward transusceptance	I_C = 1 mA V_{CE} = 7 V				
		f = 470 kHz		40		µS
		f = 10.7 MHz		0.95		mS
g_{oe}	Output conductance	I_C = 1 mA V_{CE} = 7 V				
		f = 470 kHz		6		µS
		f = 10.7 MHz		11		µS
b_{oe}	Output susceptance	I_C = 1 mA V_{CE} = 7 V				
		f = 470 kHz		4.5		µS
		f = 10.7 MHz		100		µS

SILICON PLANAR PNP

BF 316A

UHF MIXER OSCILLATOR

The BF 316 A is a silicon planar epitaxial PNP transistor in a TO-72 metal case. It is specifically designed for use as oscillator-mixer in UHF tuners.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-40	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-35	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-3	V
I_C	Collector current	-20	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25\ °C$	200	mW
T_{stg}	Storage temperature	-55 to 200	°C
T_j	Junction temperature	200	°C

MECHANICAL DATA

Dimensions in mm

(sim. to **TO-72**)

BF 316A

THERMAL DATA

$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	875	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)	V_{CB} = -20 V			-100	nA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = -10 μA	-40			V
$V_{(BR)\ CEO}$	Collector-emitter breakdown voltage (I_B = 0)	I_C = -3 mA	-35			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = -10 μA	-3			V
V_{BE}	Base-emitter voltage	I_C = -3 mA V_{CE} = -10 V		-0.75		V
h_{FE}	DC current gain	I_C = -3 mA V_{CE} = -10 V	30	50		—
f_T	Transition frequency	I_C = -3 mA V_{CE} = -10 V		600		MHz
$-C_{re}$	Feedback capacitance	I_C = 0 V_{CE} = -10 V f = 1 MHz		0.25		pF
NF	Noise figure	I_C = -3 mA V_{CB} = -10 V R_g = 50 Ω f = 800 MHz		5		dB
		I_C = -3 mA V_{CB} = -10 V R_g = 50 Ω f = 500 MHz		3.5		dB
G_{pb}	Power gain	I_C = -3 mA V_{CB} = -10 V R_L = 2 kΩ f = 800 MHz		12		dB
		I_C = -3 mA V_{CB} = -10 V R_L = 2 kΩ f = 500 MHz		17		dB

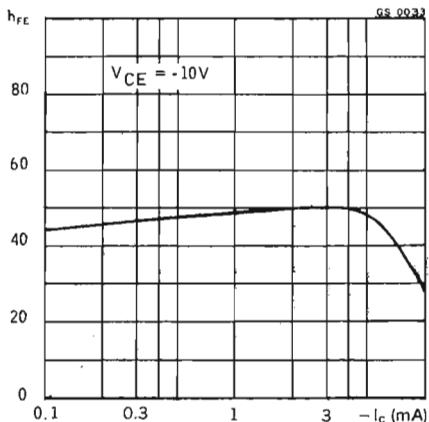
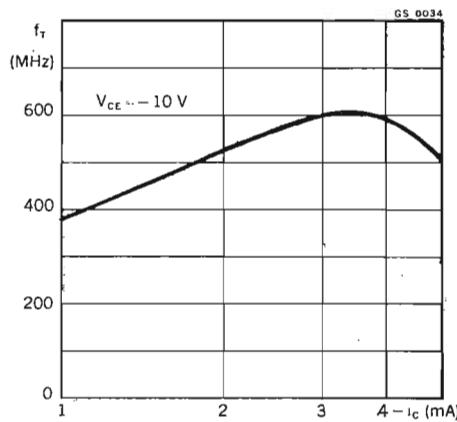
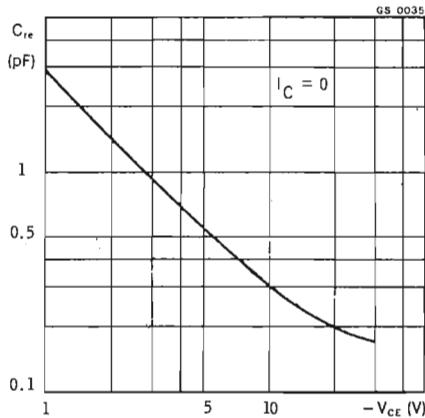
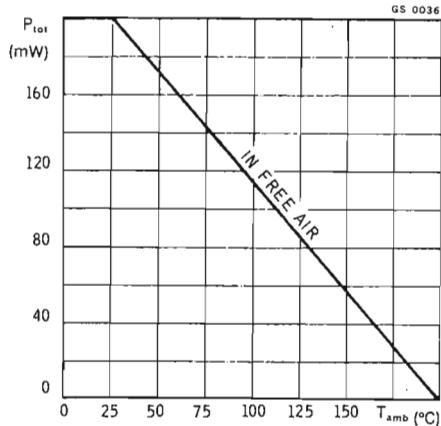
ELECTRICAL CHARACTERISTICS (continued)

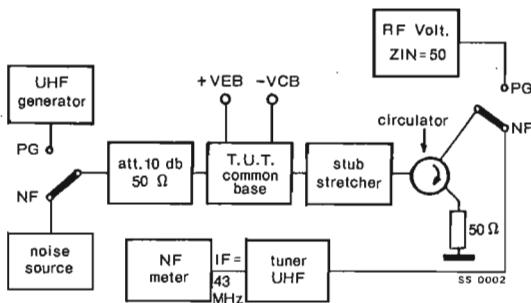
Parameter		Test conditions	Min.	Typ.	Max.	Unit
g_{ib}	Input conductance	I_C = -3 mA V_{CB} = -10 V f = 800 MHz		4.6		mS
		I_C = -3 mA V_{CB} = -10 V f = 500 MHz		17		mS
b_{ib}	Input susceptance	I_C = -3 mA V_{CB} = -10 V f = 800 MHz		-23		mS
		I_C = -3 mA V_{CB} = -10 V f = 500 MHz		-37		mS
g_{ob}	Output conductance	I_C = -3 mA V_{CB} = -10 V f = 800 MHz		0.6		mS
		I_C = -3 mA V_{CB} = -10 V f = 500 MHz		0.32		mS
b_{ob}	Output susceptance	I_C = -3 mA V_{CB} = -10 V f = 800 MHz		5		mS
		I_C = -3 mA V_{CB} = -10 V f = 500 MHz		3.2		mS
g_{fb}	Forward transconductance	I_C = -3 mA V_{CB} = -10 V f = 800 MHz		16		mS
		I_C = -3 mA V_{CB} = -10 V f = 500 MHz		10		mS
b_{fb}	Forward transusceptance	I_C = -3 mA V_{CB} = -10 V f = 800 MHz		13		mS
		I_C = -3 mA V_{CB} = -10 V f = 500 MHz		39		mS
g_{rb}	Reverse transconductance	I_C = -3 mA V_{CB} = -10 V f = 800 MHz		-0.1		mS
		I_C = -3 mA V_{CB} = -10 V f = 500 MHz		-0.04		mS
b_{rb}	Reverse transusceptance	I_C = -3 mA V_{CB} = -10 V f = 800 MHz		-0.32		mS
		I_C = -3 mA V_{CB} = -10 V f = 500 MHz		-0.26		mS

BF 316A

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min. Typ. Max.	Unit
φ_{fb}-φ_{ib}	Phase difference	I_C = -3 mA V_{CB} = -10 V f = 800 MHz I_C = -3 mA V_{CB} = -10 V f = 500 MHz	118° 141°	— —
R_{ob}	Output resistance	I_C = -3 mA V_{CB} = -10 V f = 43 MHz	0.02	mS
g_{ob}	Output conductance	I_C = -3 mA V_{CB} = -10 V f = 43 MHz	1	pF

DC current gain

Transition frequency

Feedback capacitance

Power rating chart

TEST CIRCUIT

Power gain, noise figure (f = 800 MHz)

SILICON PLANAR NPN

BF 454

AM/FM IF AMPLIFIER

The BF 454 is a silicon planar NPN transistor in a TO-18 epoxy package, with low reverse capacitance, very low noise, high output impedance.
The BF 454 is especially suited for FM tuner stages, AM mixer/oscillators and for AM/FM IF amplifiers.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	35	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	25	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4	V
I_C	Collector current	20	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25\,°C$	200	mW
	at $T_{case} \leq 25\,°C$	500	mW
T_{stg}	Storage temperature	-55 to 125	°C
T_j	Junction temperature	125	°C

MECHANICAL DATA

Dimensions in mm

TO-18 epoxy

BF 454

THERMAL DATA

$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	500	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

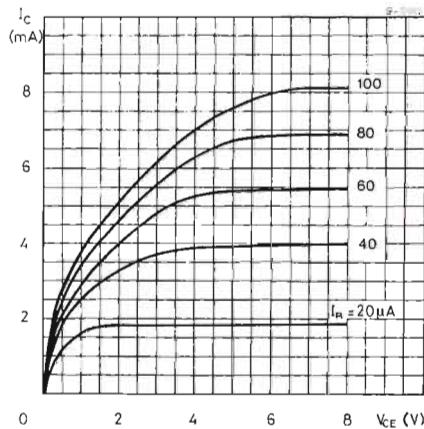
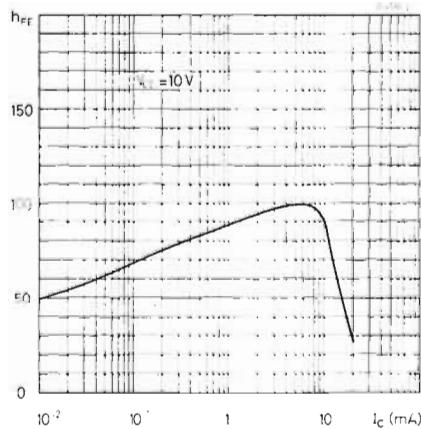
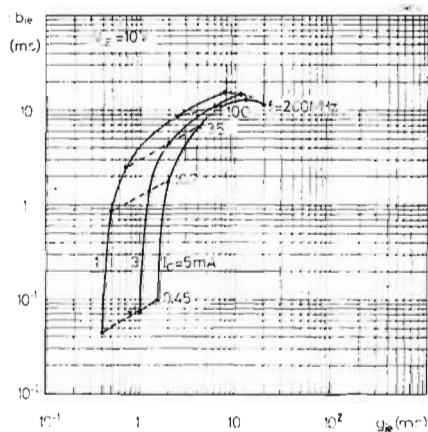
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	$V_{CB} = 10$ V			200	nA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage ($I_E = 0$)	$I_C = 100\ \mu A$	35			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage ($I_B = 0$)	$I_C = 1$ mA	25			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 10\ \mu A$	4			V
V_{BE}	Base-emitter voltage	$I_C = 1$ mA $V_{CE} = 10$ V		0.71		V
h_{FE}	DC current gain Gr. B	$I_C = 1$ mA $V_{CE} = 10$ V	110		200	—
		$I_C = 1$ mA $V_{CE} = 10$ V	65		220	—
f_T	Transition frequency	$I_C = 1$ mA $V_{CE} = 10$ V f = 100 MHz		400		MHz
$-C_{re}$	Reverse capacitance	$I_C = 0$ $V_{CE} = 10$ V f = 1 MHz		0.5	0.8	pF
NF	Noise figure	$I_C = 1$ mA $V_{CE} = 10$ V $R_g = 100\ \Omega$ f = 100 MHz		3		dB

* Pulsed: pulse duration = 300 μs, duty factor = 1%.

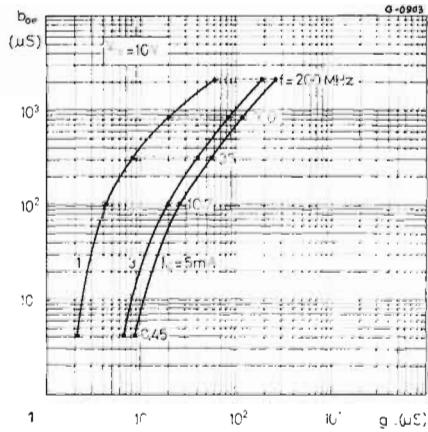
ELECTRICAL CHARACTERISTICS (continued)

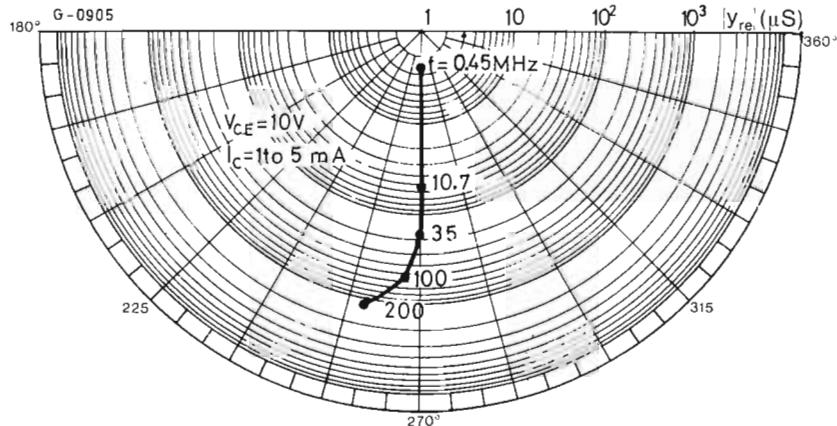
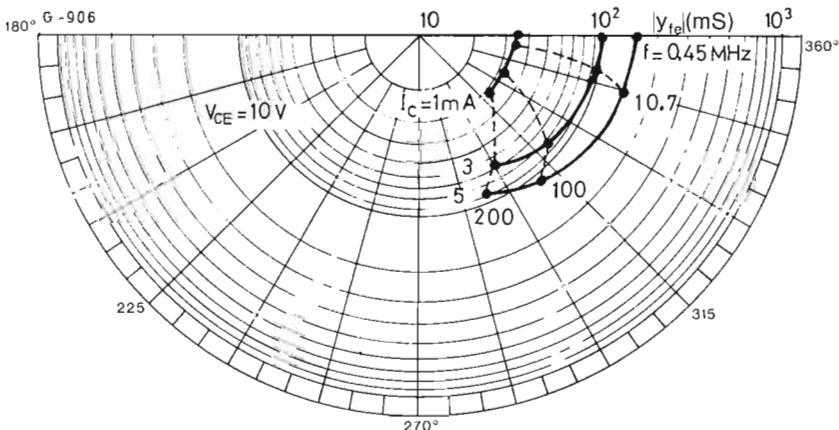
Parameter		Test conditions	Min.	Typ.	Max.	Unit
g_{ib}	Input conductance	I_C = 1 mA V_{CE} = 10 V f = 100 MHz		36		mS
$-b_{ib}$	Input susceptance			3.5		mS
$\|Y_{fb}\|$	Forward transadmittance			34		mS
φ_{fb}	Phase angle of the forward transadmittance			160°		—
g_{ob}	Output conductance			22		µS
b_{ob}	Output susceptance			0.86		mS

BF 454

Typical output characteristics

Typical DC current gain

Typical input admittance *

Typical output admittance *

* Lead length = 3 mm.

Typical reverse transadmittance *

Typical forward transadmittance *

* Lead length = 3 mm.

BF 455

SILICON PLANAR NPN

PREAMPLIFIER AND AM/FM IF AMPLIFIER

The BF 455 is a silicon planar NPN transistor in TO-18 epoxy package, with low reverse capacitance, very low noise, high output impedance.
The BF 455 is especially suited for FM tuners, IF amplifiers in AM/FM receivers, AM input stages of car-radios.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	35	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	25	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4	V
I_C	Collector current	20	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25\,°C$	200	mW
	at $T_{case} \leq 25\,°C$	500	mW
T_{stg}	Storage temperature	-55 to 125	°C
T_j	Junction temperature	125	°C

MECHANICAL DATA

Dimensions in mm

TO-18 epoxy

5/73

BF 455

THERMAL DATA

$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	500	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

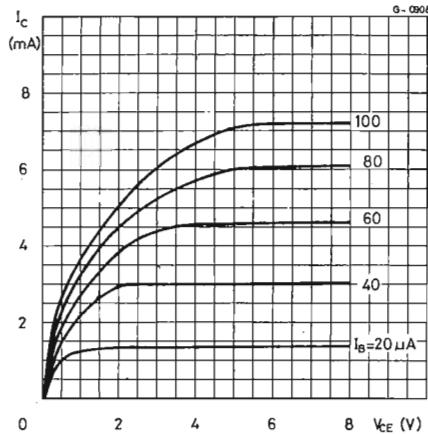
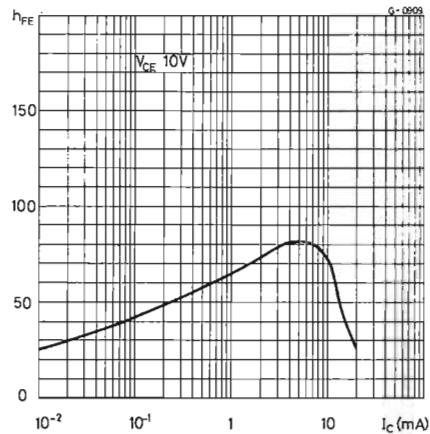
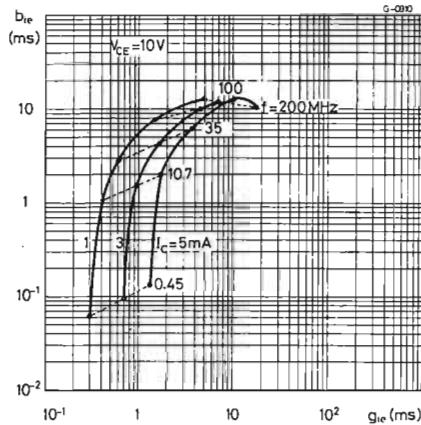
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	V_{CB} = 10 V			200	nA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage ($I_E = 0$)	I_C = 100 μA	35			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage ($I_B = 0$)	I_C = 1 mA	25			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	I_E = 10 μA	4			V
V_{BE}	Base-emitter voltage	I_C = 1 mA V_{CE} = 10 V		0.71		V
h_{FE}	DC current gain Gr. C	I_C = 1 mA V_{CE} = 10 V	68		120	—
	Gr. D	I_C = 1 mA V_{CE} = 10 V	38		75	—
		I_C = 1 mA V_{CE} = 10 V	35		125	—
f_T	Transition frequency	I_C = 1 mA V_{CE} = 10 V f = 100 MHz		400		MHz
$-C_{re}$	Reverse capacitance	I_C = 0 V_{CE} = 10 V f = 1 MHz		0.5	0.8	pF
NF	Noise figure	I_C = 1 mA V_{CE} = 10 V R_g = 100 Ω f = 100 MHz		3		dB

* Pulsed: pulse duration = 300 μs, duty factor = 1%.

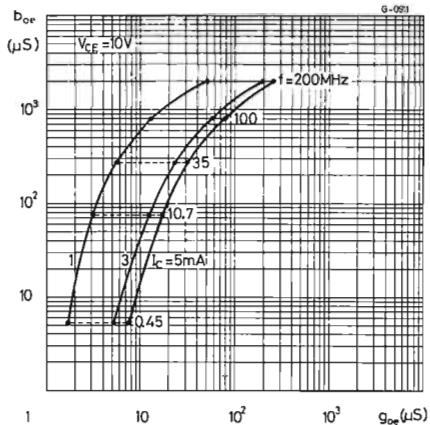
ELECTRICAL CHARACTERISTICS (continued)

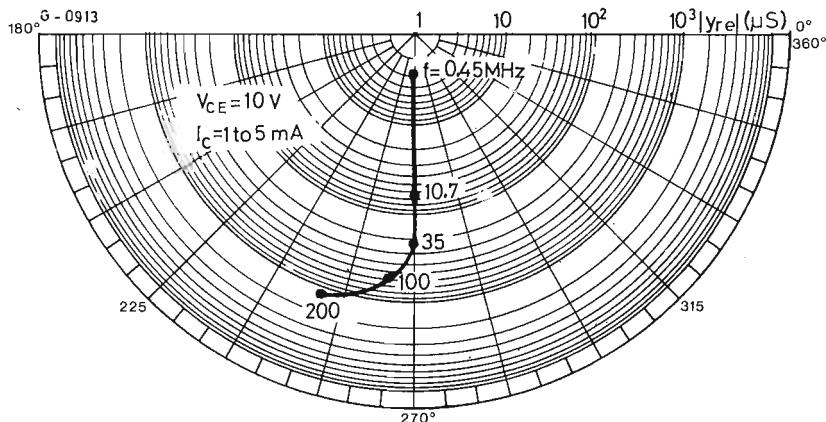
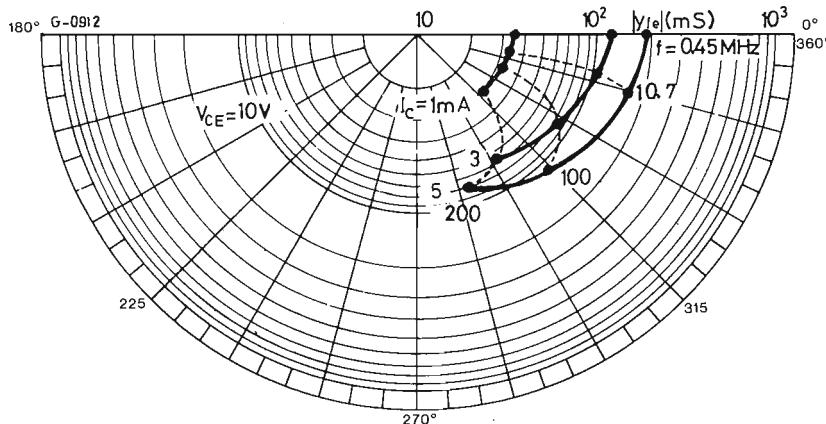
Parameter		Test conditions	Min.	Typ.	Max.	Unit
g_{ib}	Input conductance	I_C = 1 mA V_{CE} = 10 V f = 100 MHz		38		mS
$-b_{ib}$	Input susceptance			2		mS
$\|Y_{fb}\|$	Forward transadmittance			34		mS
φ_{fb}	Phase angle of the forward transadmittance			150°		—
g_{ob}	Output conductance			13		μS
b_{ob}	Output susceptance			0.8		mS

BF 455

Typical output characteristics

Typical DC current gain

Typical input admittance *

Typical output admittance *

* Lead length = 3 mm.

Typical reverse transadmittance *

Typical forward transadmittance *

* Lead length = 3 mm.

BF 479

SILICON PLANAR PNP

PRELIMINARY DATA

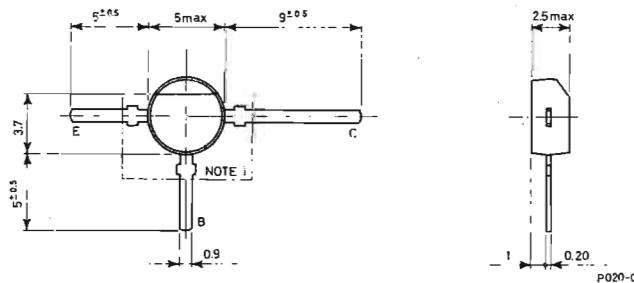
LOW-NOISE ULTRA LINEAR UHF-VHF AMPLIFIER

The BF 479 is a PNP silicon planar epitaxial transistor in a T-plastic package mainly intended for high current UHF-VHF stages of TV tuners.
In this application, combined with a PIN diode attenuator circuit, it presents very low noise and very good cross modulation performances up to 900 MHz.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-30	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-25	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-3	V
I_C	Collector current	-50	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 45\ °C$	170	mW
T_{stg}	Storage temperature	-55 to 150	°C
T_j	Junction temperature	150	°C

MECHANICAL DATA

Dimensions in mm

(1) Within this region the cross section of the leads is uncontrolled

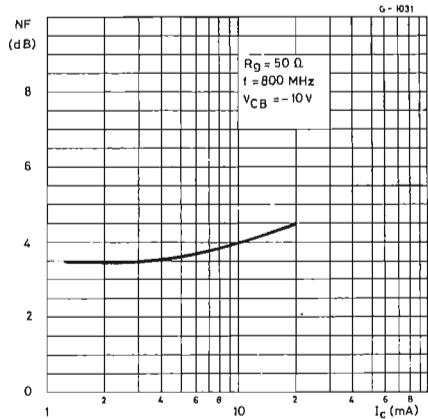
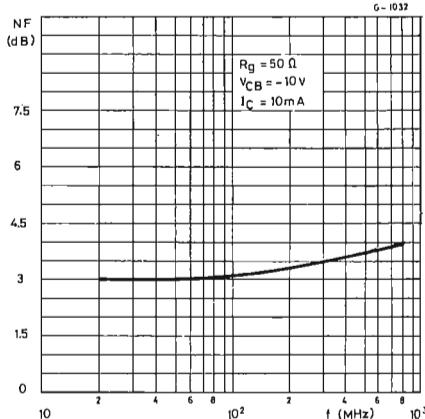
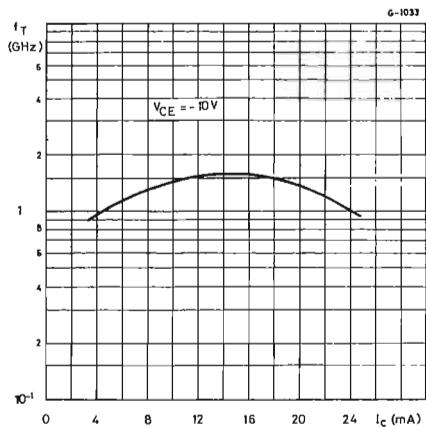
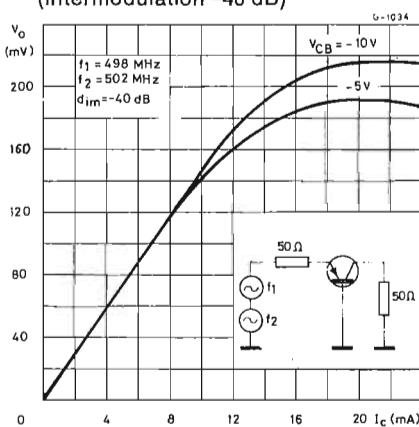
BF 479

THERMAL DATA

$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	600	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)	V_{CB} = -20 V			-100	nA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = -100 μA	-30			V
$V_{(BR)\ CEO}$	Collector-emitter breakdown voltage (I_B = 0)	I_C = -5 mA	-25			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = -10 μA	-3			V
h_{FE}	DC current gain	I_C = -10 mA V_{CE} = -10 V	20			—
f_T	Transition frequency	I_C = -10 mA V_{CE} = -10 V f = 100 MHz		1.4		GHz
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = -10 V f = 1 MHz		0.7		pF
NF	Noise figure	V_{CB} = -10 V R_g = 50 Ω				
		I_C = -3 mA f = 200 MHz		2.5		dB
		I_C = -10 mA f = 200 MHz		3.3		dB
		I_C = -3 mA f = 800 MHz		3.5	5.5	dB
		I_C = -10 mA f = 800 MHz		4	6	dB
G_{pb}	Power gain	I_C = -10 mA V_{CB} = -10 V R_L = 2 kΩ f = 800 MHz	15	18		dB

Typical noise figure

Typical noise figure

Typical transition frequency

Typical output voltage
(intermodulation −40 dB)

SILICON PLANAR PNP

BF 500
BF 500A

PRELIMINARY DATA

VHF PREAMPLIFIERS AND MIXER/OSCILLATORS

The BF 500 and BF 500 A are silicon planar epitaxial PNP transistors in TO-18 epoxy package, designed for use as preamplifiers and mixer/oscillators up to 200 MHz in common base connection.

The BF 500 A has a very low guaranteed input noise.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-30	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-30	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-3	V
I_C	Collector current	-20	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25\ °C$	200	mW
T_{stg}	Storage temperature	-55 to 125	°C
T_j	Junction temperature	125	°C

MECHANICAL DATA

Dimensions in mm

TO-18 epoxy

BF 500
BF 500A

THERMAL DATA

$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	500	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	$V_{CB} = -10$ V			-100	nA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage ($I_E = 0$)	$I_C = -10\ \mu A$	-30			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage ($I_B = 0$)	$I_C = -1$ mA	-30			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	$I_E = -10\ \mu A$	-4			V
h_{FE}	DC current gain	$I_C = -1$ mA $V_{CE} = -10$ V $I_C = -4$ mA $V_{CE} = -10$ V	30	50 50		— —
f_T	Transition frequency	$I_C = -1$ mA $V_{CE} = -10$ V f = 100 MHz		400		MHz
NF	Noise figure (for **BF 500 A** only)	$I_C = -1$ mA $V_{CB} = -6$ V $R_g = 100\ \Omega$ f = 100 MHz		2	4	dB
C_{rb}	Reverse capacitance	$I_C = 0$ $V_{CB} = -10$ V f = 1 MHz		0.3		pF

* Pulsed: pulse duration = 300 μs, duty factor = 1%.

BF 500
BF 500A

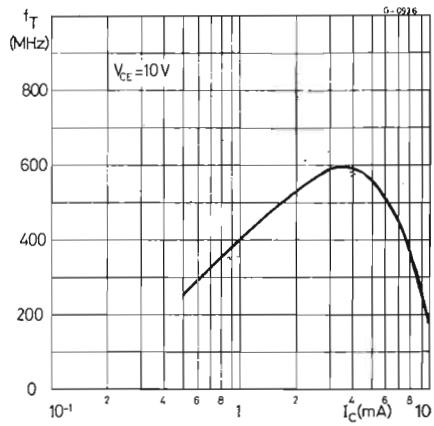
ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
g_{ib}	Input conductance	I_C = -1 mA V_{CB} = -6 V f = 100 MHz		36		mS
b_{ib}	Input susceptance			4		mS
$\|Y_{fb}\|$	Forward transadmittance			36		mS
φ_{fb}	Phase angle of the forward transadmittance			167°		—
g_{ob}	Output conductance			10		μS
b_{ob}	Output susceptance			0.7		mS

Typical output characteristics

Typical DC current gain

BF 500
BF 500A

Typical transition frequency

BF 516

SILICON PLANAR PNP

UHF-VHF AMPLIFIER

The BF 516 is a silicon planar epitaxial PNP transistor in a TO-72 metal case, intended as general purpose amplifier up to 1 GHz.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-40	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-35	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-3	V
I_C	Collector current	-20	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25$ °C	200	mW
T_{stg}	Storage temperature	-55 to 200	°C
T_j	Junction temperature	200	°C

MECHANICAL DATA

Dimensions in mm

(sim. to **TO-72**)

BF 516

THERMAL DATA

$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	875	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)	V_{CB} = -20 V			-100	nA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = -10 μA	-40			V
$V_{(BR)\ CEO}$	Collector-emitter breakdown voltage (I_B = 0)	I_C = -3 mA	-35			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = -10 μA	-3			V
V_{BE}	Base-emitter voltage	I_C = -3 mA V_{CE} = -10 V		-0.75		V
h_{FE}	DC current gain	I_C = -3 mA V_{CE} = -10 V	25	50		—
f_T	Transition frequency	I_C = -3 mA V_{CE} = -10 V	700	850		MHz
$-C_{re}$	Feedback capacitance	I_C = 0 V_{CB} = -10 V f = 1 MHz		0.3		pF
C_{rb}	Feedback capacitance	I_C = 0 V_{CE} = -10 V f = 1 MHz		0.05	0.09	pF
NF	Noise figure	I_C = -3 mA V_{CB} = -12 V R_g = 50 Ω f = 800 MHz		3.5	6	dB
		I_C = -3 mA V_{CB} = -12 V R_g = 50 Ω f = 200 MHz		2.5		dB
G_{pb}	Power gain	I_C = -3 mA V_{CB} = -12 V R_L = 2 kΩ f = 800 MHz	11	14		dB
		I_C = -3 mA V_{CB} = -12 V R_L = 2 kΩ f = 200 MHz		19		dB

ELECTRICAL CHARACTERISTICS (continued)

	Parameter	Test conditions	Min. Typ. Max.	Unit
g_{ib}	Input conductance	I_C = -3 mA V_{CB} = -10 V f = 800 MHz	7	mS
		I_C = -3 mA V_{CB} = -10 V f = 200 MHz	60	mS
b_{ib}	Input susceptance	I_C = -3 mA V_{CB} = -10 V f = 800 MHz	-26	mS
		I_C = -3 mA V_{CB} = -10 V f = 200 MHz	-36	mS
g_{ob}	Output conductance	I_C = -3 mA V_{CB} = -10 V f = 800 MHz	0.77	mS
		I_C = -3 mA V_{CB} = -10 V f = 200 MHz	0.10	mS
b_{ob}	Output susceptance	I_C = -3 mA V_{CB} = -10 V f = 800 MHz	5	mS
		I_C = -3 mA V_{CB} = -10 V f = 200 MHz	1.3	mS
g_{fb}	Forward transconductance	I_C = -3 mA V_{CB} = -10 V f = 800 MHz	11	mS
		I_C = -3 mA V_{CB} = -10 V f = 200 MHz	-51	mS
b_{fb}	Forward transusceptance	I_C = -3 mA V_{CB} = -10 V f = 800 MHz	23	mS
		I_C = -3 mA V_{CB} = -10 V f = 200 MHz	45	mS
g_{rb}	Reverse transconductance	I_C = -3 mA V_{CB} = -10 V f = 800 MHz	-0.1	mS
		I_C = -3 mA V_{CB} = -10 V f = 200 MHz	-0.02	mS
b_{rb}	Reverse transusceptance	I_C = -3 mA V_{CB} = -10 V f = 800 MHz	-0.35	mS
		I_C = -3 mA V_{CB} = -10 V f = 200 MHz	-0.1	mS

BF 516

Normalized DC current gain

Transition frequency

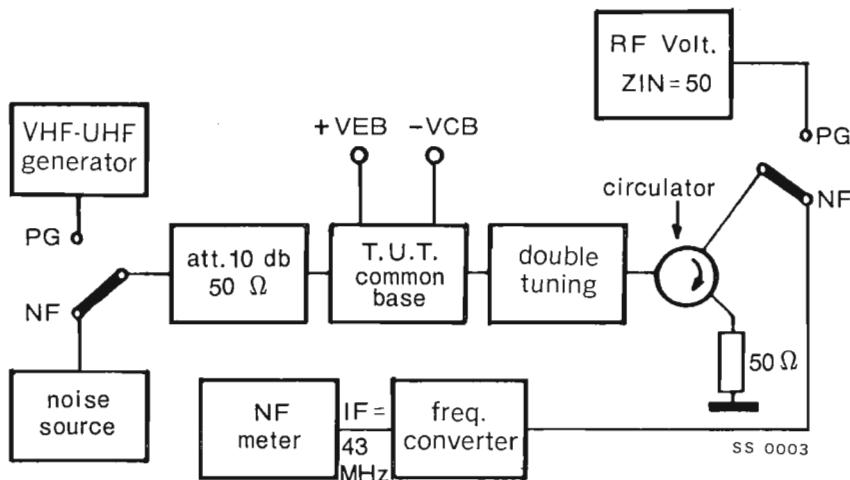
Feedback capacitance

Power gain

Noise figure

Power rating chart

TEST CIRCUIT

Power gain, AGC and noise figure (f = 200 to 800 MHz)

INTEGRATED CIRCUITS

LINEAR INTEGRATED CIRCUIT

TAA 550
TBA 271

VOLTAGE STABILIZER

- LOW TEMPERATURE COEFFICIENT
- LOW ZENER RESISTANCE

The TAA 550/TBA 271 is a monolithic integrated voltage stabilizer in a TO-18 two pins metal case. It is especially designed as voltage supplier for varicap diodes in television tuners.
The TAA 550/TBA 271 is supplied in 3 groups of stabilized voltage identified by a letter after the code, as shown in the "ORDERING NUMBERS"

ABSOLUTE MAXIMUM RATINGS

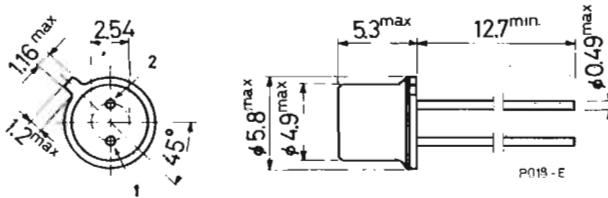
I_z	Zener current at $T_{case} \leq 70\,°C$	15 mA
T_{stg}	Storage temperature	-20 to 150 °C
T_{op}	Operating temperature	*

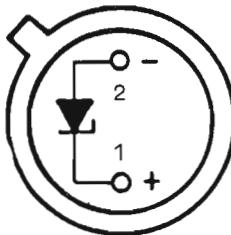
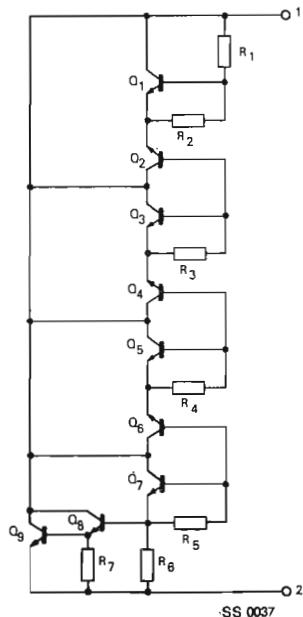
* Refer to "Power rating chart" (Fig. 1).

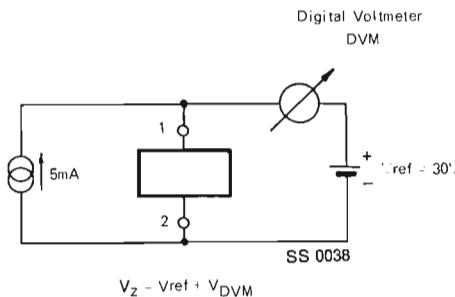
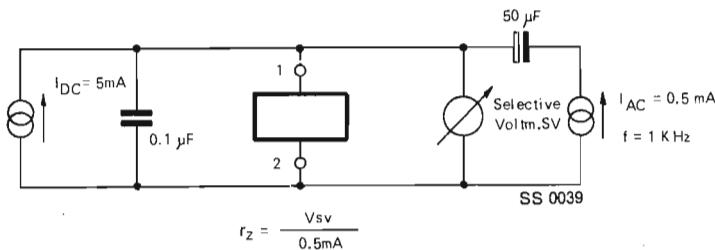
ORDERING NUMBERS: TAA 550 A or TBA 271 A (for V_s range : 30-32 V)
TAA 550 B or TBA 271 B (for V_s range : 32-34 V)
TAA 550 C or TBA 271 C (for V_s range : 34-36 V)

MECHANICAL DATA

Dimensions in mm

Lead 1 connected to case

TAA 550
TBA 271

CONNECTION DIAGRAM (bottom view)

SCHEMATIC DIAGRAM

TEST CIRCUITS

Circuit No. 1 (for V_z measurement)

Circuit No. 2 (for r_z measurement)

TAA 550
TBA 271

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	150	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	400	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
V_z	Zener voltage	I_z = 5 mA (circuit No. 1)				
		for **TAA 550 A/TBA 271 A**	30	31	32.2	V
		for **TAA 550 B/TBA 271 B**	32	33	34.2	V
		for **TAA 550 C/TBA 271 C**	34	35	36	V
r_z	Zener dynamic resistance	I_z = 5 mA I_{AC} = 0.5 mA f = 1 kHz (circuit No. 2)		10	25	Ω
$\frac{\Delta V_z}{\Delta T_{amb}}$	Temperature coefficient	I_z = 5 mA ΔT_{amb} = 0 to 50 °C	-3.2		+1.6	mV/°C

Fig. 1 - Power rating chart

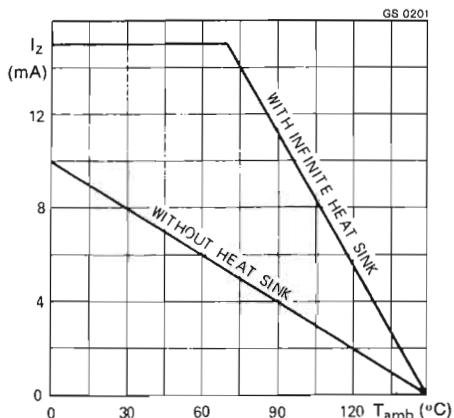



Fig. 2 - Typical zener dynamic resistance vs zener current

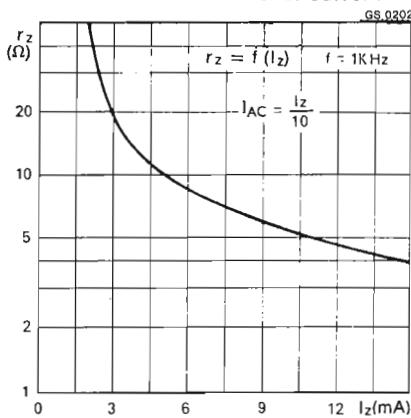



Fig. 3 - Typical temperature coefficient

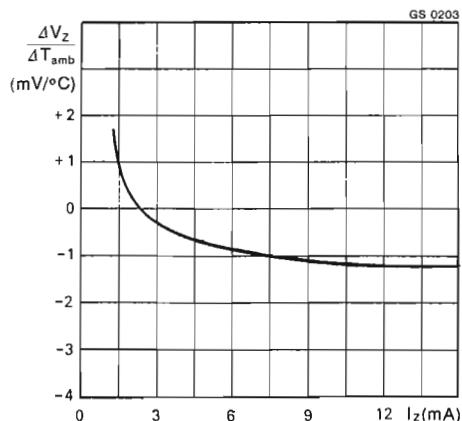
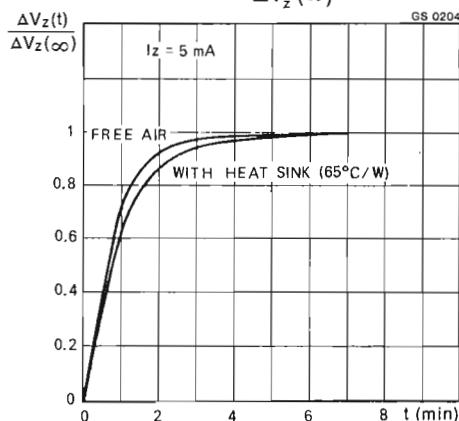
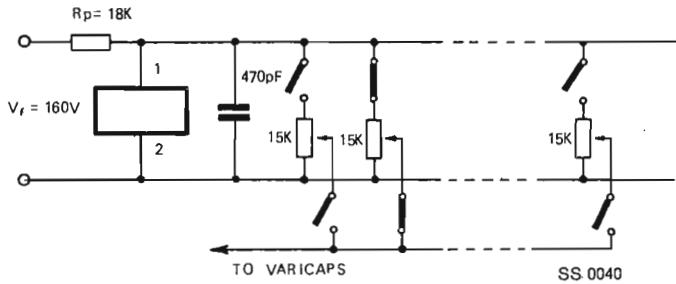



Fig. 4 - Typical $\frac{\Delta V_z (t)}{\Delta V_z (\infty)}$ vs time

TYPICAL APPLICATION

TAA 611A

LINEAR INTEGRATED CIRCUIT

AUDIO AMPLIFIER

- OUTPUT POWER 1.8 W (9 V - 4 Ω)
- LOW DISTORTION
- LOW QUIESCENT CURRENT
- HIGH INPUT IMPEDANCE

The TAA 611 A is a monolithic integrated circuit in a 14-lead quad in-line plastic package or in a TO-96 metal case.
It is particularly designed for use in radio receivers and record-players as audio amplifier. The usable range of supply voltage varies from 6 V to 10 V and the circuit requires a minimum number of external components.

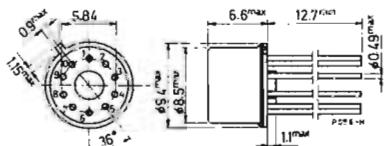
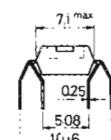
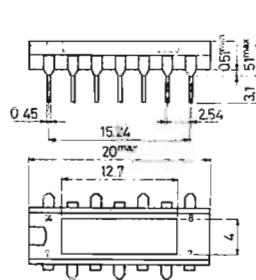
ABSOLUTE MAXIMUM RATINGS

		TAA 611 A12	TAA 611 A55
V_s	Supply voltage	12 V	
V_i*	Input voltage	-0.5 to 12 V	
I_o	Output peak current	1 A	
P_{tot}	Power dissipation at $T_{amb} \leq 25\,°C$	1.35 W	0.57 W
	at $T_{case} \leq 70\,°C$	—	1.15 W
T_{stg}	Storage temperature	-55 to 125 °C	-55 to 150 °C
T_j	Junction temperature	150 °C	

* For $V_s < 12\,V$, $V_{i\,max} = V_s$

ORDERING NUMBERS: TAA 611 A55 (for TO-100 metal case)
TAA 611 A12 (for quad in-line plastic package)

MECHANICAL DATA

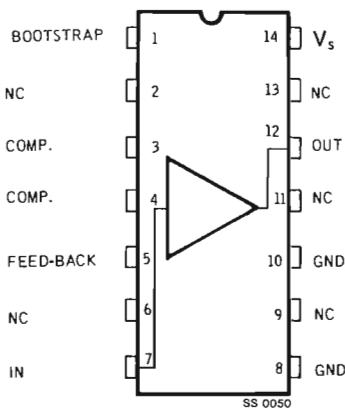
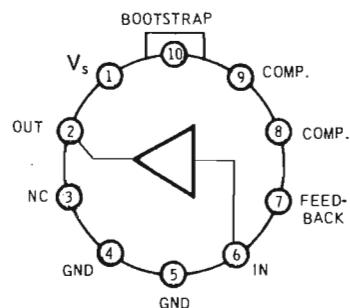
Dimensions in mm

TAA 611 A55

TAA 611 A12

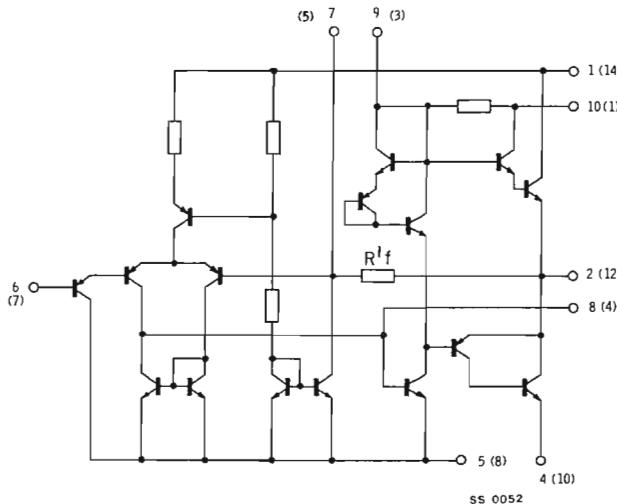
TAA 611A

CONNECTION DIAGRAMS (top views)

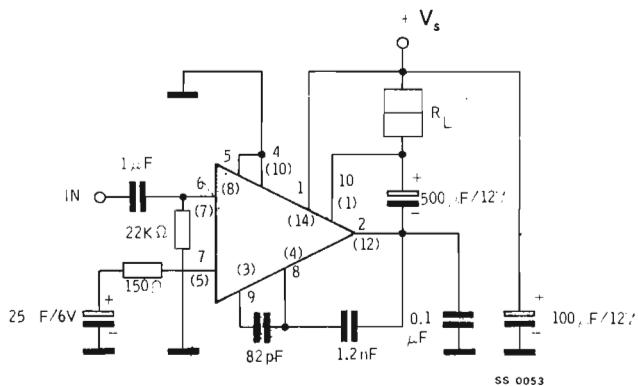
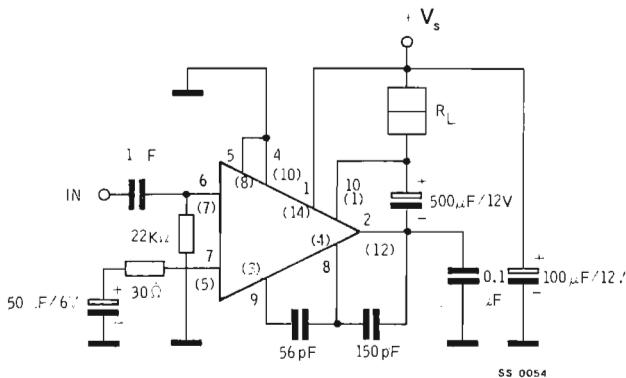
For **TAA 611 A12**

BOOTSTRAP 1 — 14 V_s
NC 2 — 13 NC
COMP. 3 — 12 OUT
COMP. 4 — 11 NC
FEED-BACK 5 — 10 GND
NC 6 — 9 NC
IN 7 — 8 GND

SS 0050

For **TAA 611 A55**

SCHEMATIC DIAGRAM

The pin numbers in brackets refer to the TAA 611 A12 and those without brackets refer to the TAA 611 A55.

TEST CIRCUITS

Circuit No. 1 ($G_v = 50$)

Circuit No. 2 ($G_v = 250$)

TAA 611A

THERMAL DATA (maximum values)		TAA 611 A12	TAA 611 A55
$R_{th\ j\text{-}case}$	Thermal resistance junction-case	—	50 °C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	93 °C/W	220 °C/W

ELECTRICAL CHARACTERISTICS

(T_{amb} = 25 °C, V_s = 9 V unless otherwise specified)

	Parameter	Test conditions		Min.	Typ.	Max.	Unit
V_o	Quiescent output voltage				4.8		V
I_d	Total quiescent drain current				3		mA
I_d	Quiescent drain current of output transistors				1		mA
I_d	Drain current	P_o = 1.15 W	R_L = 8 Ω		170		mA
I_b	Input bias current				60		nA
P_o*	Output power	d = 2%					
		V_s = 6 V	R_L = 4 Ω		0.50		W
		V_s = 6 V	R_L = 8 Ω		0.35		W
		V_s = 9 V	R_L = 4 Ω		1.4		W
		V_s = 9 V	R_L = 8 Ω		0.9		W
		d = 10%					
		V_s = 6 V	R_L = 4 Ω		0.65		W
		V_s = 6 V	R_L = 8 Ω		0.45		W
		V_s = 9 V	R_L = 4 Ω		1.8		W
		V_s = 9 V	R_L = 8 Ω	0.85	1.15		W
R_f'	Internal feedback resistance (see schematic diagram)				7.5		kΩ
Z_i	Input impedance (open loop)				0.75		MΩ

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
d	Distortion	Test circuit 1				
		P_o = 50 mW V_s = 9 V R_L = 8 Ω f = 1 kHz		0.4		%
		P_o = 0.5 W V_s = 9 V R_L = 8 Ω f = 1 kHz		0.3		%
		Test circuit 2				
		P_o = 50 mW V_s = 9 V R_L = 8 Ω f = 1 kHz		1.7		%
		P_o = 0.5 W V_s = 9 V R_L = 8 Ω f = 1 kHz		1.2		%
G_v	Voltage gain (open loop)	R_L = 8 Ω		68		dB

* External heat-sink not required except for TAA 611 A55 at V_s = 9 V, R_L = 4 Ω.

Fig. 1 - Typical output power vs load resistance

Fig. 2 - Typical output power vs load resistance

Fig. 3 - Typical distortion vs output power

GS 0225

d (%)

V_s = 9 V
R_L = 8Ω
f = 1KHz

TEST CIRCUIT 2
TEST CIRCUIT 1

P_o (W)

Fig. 4 - Typical distortion vs output power

GS 0226

d (%)

V_s = 9 V
R_L = 4Ω
f = 1KHz

TEST CIRCUIT 2
TEST CIRCUIT 1

P_o (W)

Fig. 5 - Typical relative frequency response

Fig. 6 - Typical relative frequency response

Fig. 7 - Typical voltage gain (open loop) vs frequency

Curve 1: TAA611 A 55, C_{9-8} = 82pF C_{8-2} = 1.2 nF C_{10-1} = 0.1 μF

TAA611 A 12, C_{3-4} = 82pF C_{4-12} = 1.2 nF C_{1-14} = 0.1 μF

Curve 2: TAA611 A 55, C_{9-8} = 56pF C_{8-2} = 150 pF C_{10-1} = 0.1 μF

TAA611 A 12, C_{3-4} = 56pF C_{4-12} = 150pF C_{1-14} = 0.1 μF

Fig. 8 - Typical output power vs input voltage

Fig. 9 - Typical output power vs input voltage

Fig. 10 - Typical power dissipation and efficiency vs output power

Fig. 11 - Typical power dissipation and efficiency vs output power

Fig. 12 - Typical power dissipation and efficiency vs output power

Fig. 13 - Typical power dissipation and efficiency vs output power

Fig. 14 - Typical drain current vs output power

Fig. 15 - Maximum power dissipation vs load resistance

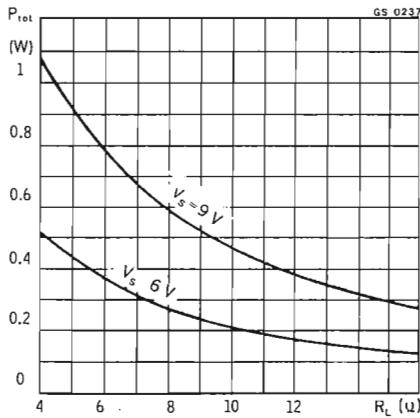



Fig. 16 - Power rating chart **(TAA 611 A55)**

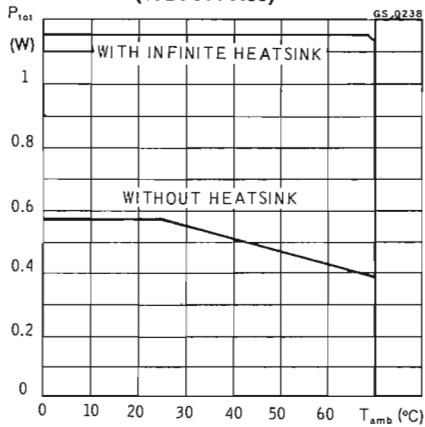



Fig. 17 - Power rating chart **(TAA 611 A12)**

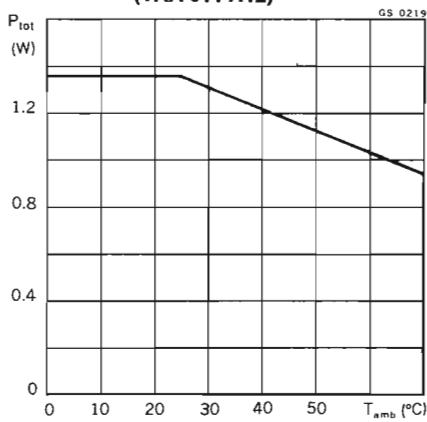



Fig. 18 - Typical quiescent drain current vs supply voltage

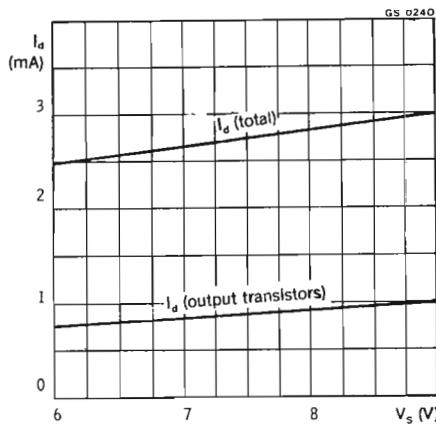



Fig. 19 - Typical quiescent drain current vs ambient temperature

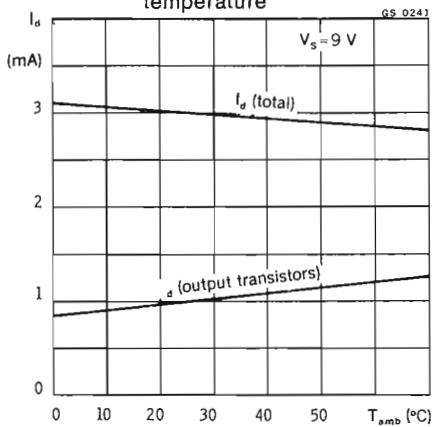



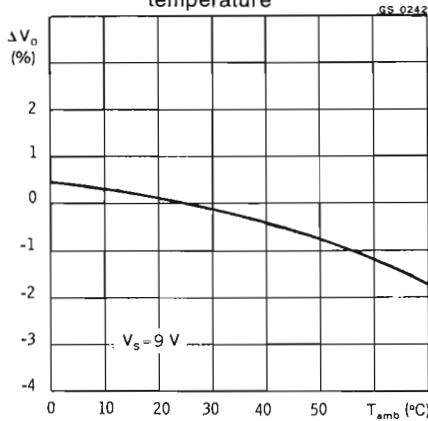
Fig. 20 - Typical quiescent output voltage vs ambient temperature

TYPICAL APPLICATIONS

Fig. 21 - Audio amplifier for record-player.

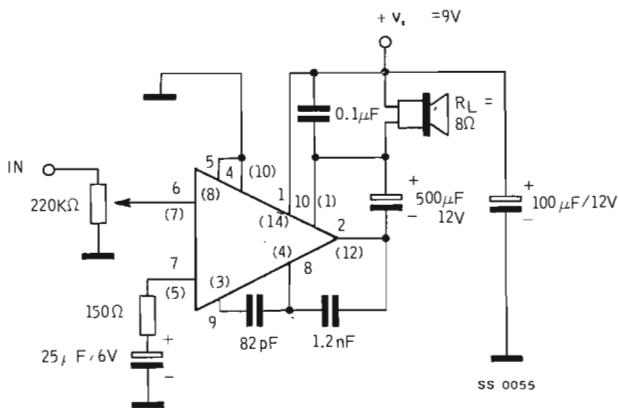
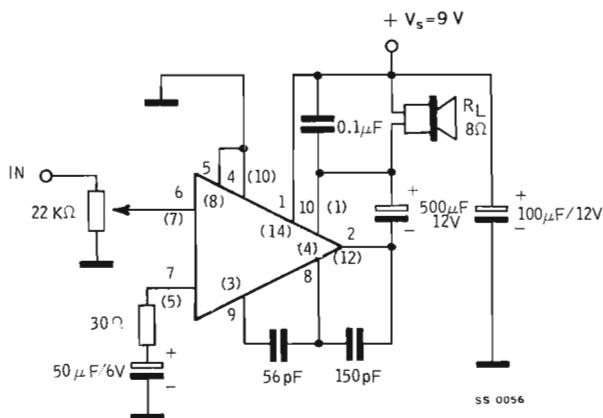



Fig. 22 - Audio amplifier for radio.

The pin numbers in brackets refer to the TAA 611 A12 and those without brackets refer to the TAA 611 A55.

TAA 611B

LINEAR INTEGRATED CIRCUIT

AUDIO AMPLIFIER

- OUTPUT POWER 2.1 W (12 V - 8 Ω)
- LOW DISTORTION
- LOW QUIESCENT CURRENT
- HIGH INPUT IMPEDANCE

The TAA 611 B is a monolithic integrated circuit in a 14-lead quad in-line plastic package.
It is particularly designed for use in radio receivers and record-players as audio amplifier. The usable range of supply voltage varies from 6 V to 15 V and the circuit requires a minimum number of external components.

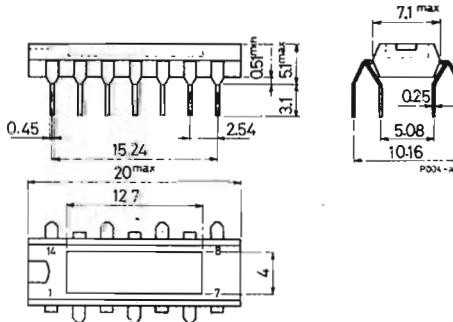
ABSOLUTE MAXIMUM RATINGS

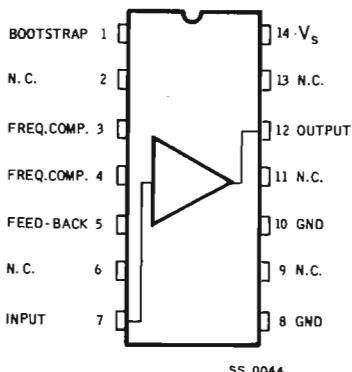
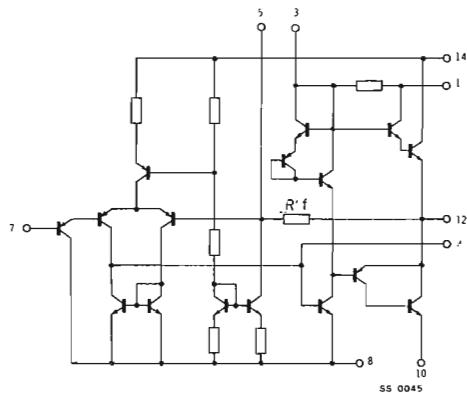
V_s	Supply voltage	15	V
V_i*	Input voltage	-0.5 to 15	V
I_o	Output peak current	1	A
P_{tot}	Power dissipation at $T_{amb} \leq 25$ °C	1.35	W
T_{stg}	Storage temperature	-55 to 125	°C
T_j	Junction temperature	150	°C

* For $V_s < 15$ V, $V_{i\,max} = V_s$

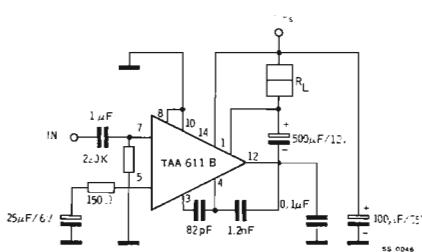
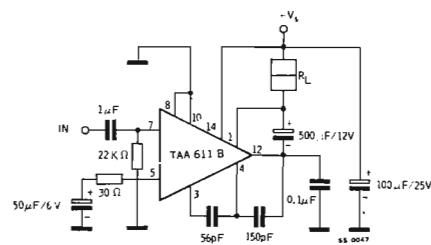
ORDERING NUMBER: TAA 611 B12

MECHANICAL DATA

Dimensions in mm

TAA 611B

CONNECTION DIAGRAM
(top view)

SCHEMATIC DIAGRAM

TEST CIRCUITS

Circuit No. 1 ($G_v = 50$)

Circuit No. 2 ($G_v = 250$)

THERMAL DATA

$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	93	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

	Parameter	Test conditions		Min.	Typ.	Max.	Unit
V_o	Quiescent output voltage	V_s = 9 V			4.8		V
		V_s = 12 V			6.3		V
I_d	Total quiescent drain current	V_s = 9 V			3		mA
		V_s = 12 V			3.5		mA
I_d	Quiescent drain current of output transistors	V_s = 9 V			1		mA
		V_s = 12 V			1.2		mA
I_d	Drain current	R_L = 8 Ω					
		P_o = 1.15 W	V_s = 9 V		170		mA
		P_o = 2.1 W	V_s = 12 V		235		mA
I_b	Input bias current	V_s = 9 V			60		nA
		V_s = 12 V			75		nA
P_o	Output power	d = 2%	R_L = 8 Ω				
			V_s = 9 V		0.9		W
			V_s = 12 V		1.7		W
		d = 10%	R_L = 8 Ω				
			V_s = 9 V		1.15		W
			V_s = 12 V	1.5	2.1		W
R_f'	Internal feedback resistance (see schematic diagram)				7.5		kΩ
Z_i	Input impedance	open loop			0.75		MΩ

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions		Min.	Typ.	Max.	Unit
d	Distortion	Test circuit 1					
		$R_L = 8\,\Omega$	$f = 1$ kHz				
		$P_o = 50$ mW	$V_s = 9$ V		0.4		%
		$P_o = 50$ mW	$V_s = 12$ V		0.3		%
		$P_o = 0.5$ W	$V_s = 9$ V		0.3		%
		$P_o = 1$ W	$V_s = 12$ V		0.2		%
		Test circuit 2					
		$R_L = 8\,\Omega$	$f = 1$ kHz				
		$P_o = 50$ mW	$V_s = 9$ V		1.7		%
		$P_o = 50$ mW	$V_s = 12$ V		1.5		%
		$P_o = 0.5$ W	$V_s = 9$ V		1.2		%
		$P_o = 1$ W	$V_s = 12$ V		1		%
G_v	Voltage gain (open loop)						
		$R_L = 8\,\Omega$	$V_s = 9$ V		68		dB
		$R_L = 8\,\Omega$	$V_s = 12$ V		70		dB

Fig. 1 - Typical output power vs load resistance

Fig. 2 - Typical output power vs load resistance

Fig. 3 - Typical distortion vs output power

Fig. 4 - Typical distortion vs output power

Fig. 7 - Typical voltage gain (open loop) vs frequency

Fig. 6 - Typical relative frequency response

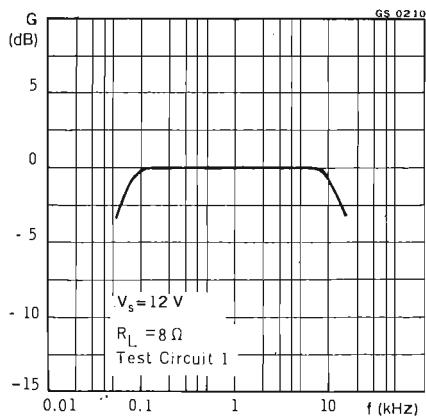



Fig. 7 - Typical relative frequency response

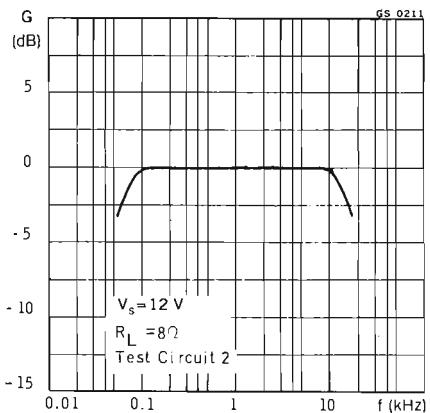
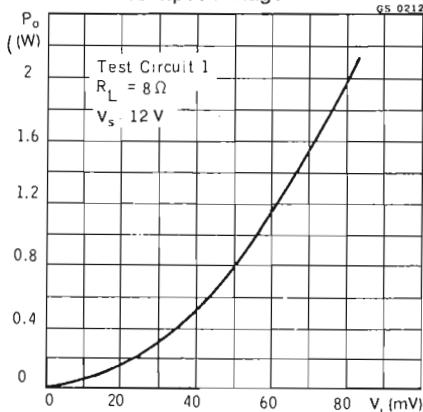



Fig. 8 - Typical output power vs input voltage

Fig. 9 - Typical output power vs input voltage

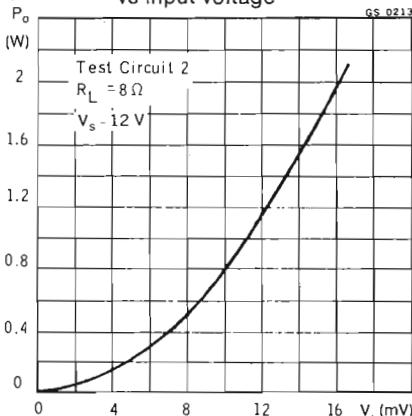



Fig. 10 - Typical power dissipation and efficiency vs output power

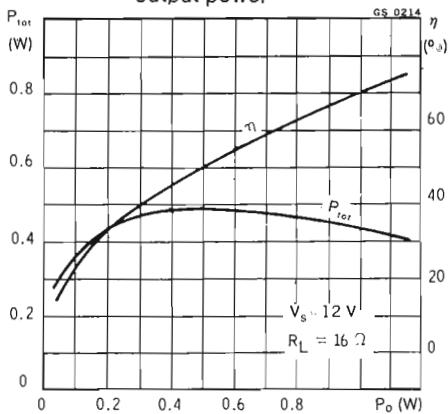



Fig. 11 - Typical power dissipation and efficiency vs output power

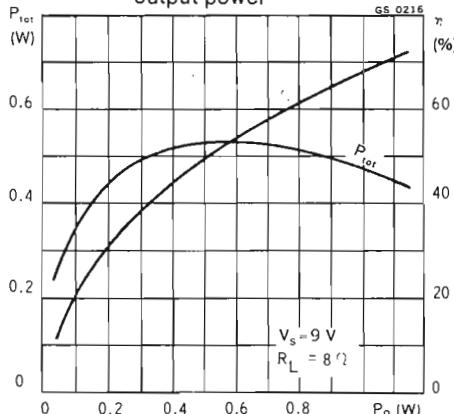



Fig. 12 - Typical power dissipation and efficiency vs output power

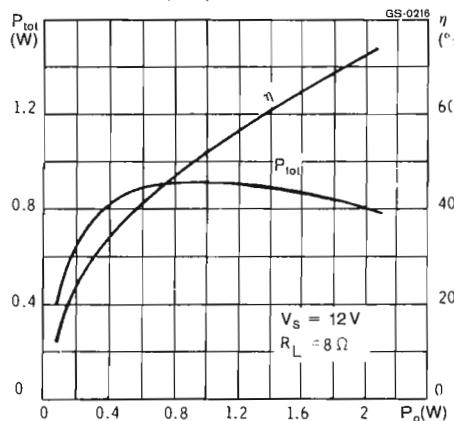



Fig. 13 - Typical drain current vs output power

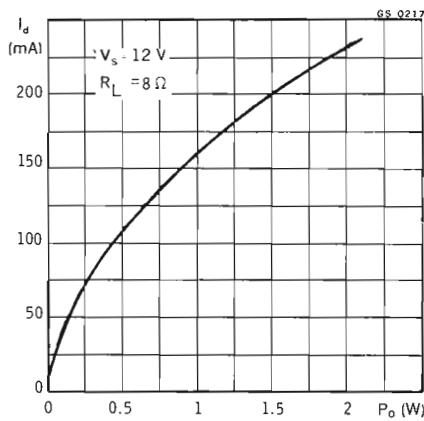



Fig. 14 - Maximum power dissipation vs load resistance

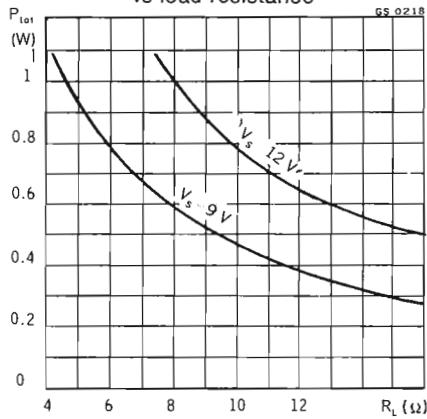



Fig. 15 - Power rating chart

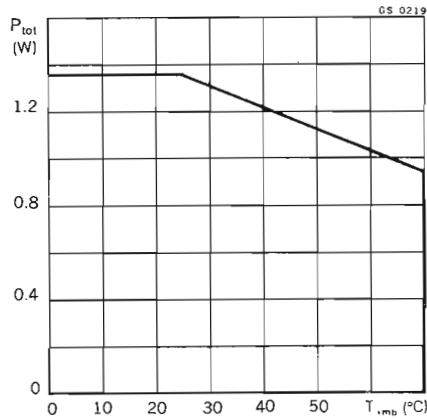



Fig. 16 - Typical quiescent drain current vs supply voltage

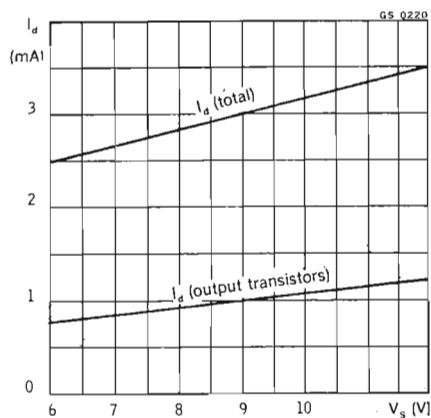



Fig. 17 - Typical quiescent drain current vs ambient temperature

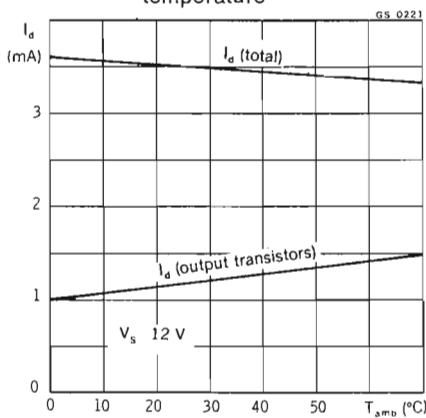
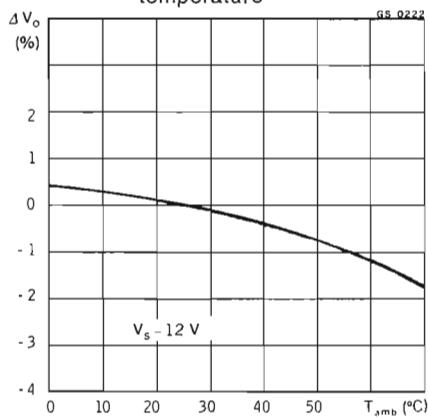



Fig. 18 - Quiescent output voltage variation vs ambient temperature

TAA 611B

TYPICAL APPLICATIONS

Fig. 19 - Audio amplifier for radio.

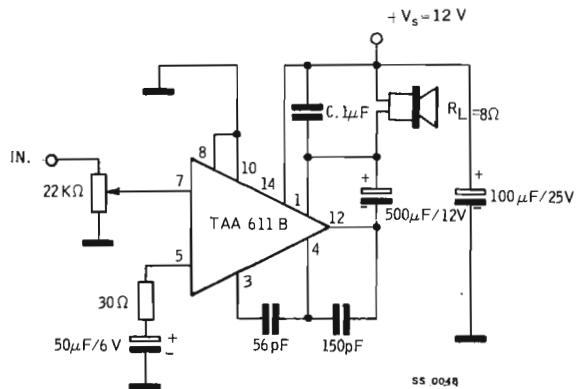
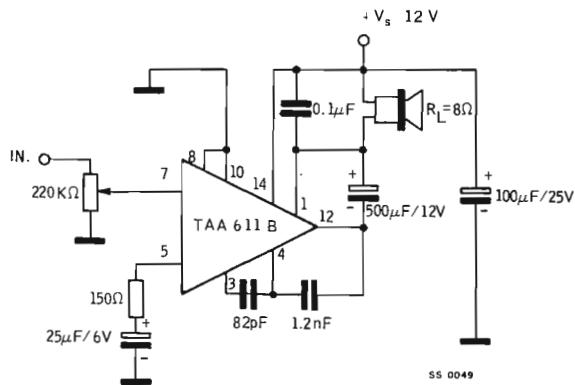



Fig. 20 - Audio amplifier for record-player.

LINEAR INTEGRATED CIRCUIT

TAA 611C

AUDIO AMPLIFIER

- OUTPUT POWER 3.3 W (15 V - 8 Ω)
- LOW DISTORTION
- LOW QUIESCENT CURRENT
- SELF CENTERING BIAS
- HIGH IMPEDANCE

The TAA 611C is a monolithic integrated circuit in a 14-lead quad in-line plastic package with external heat-sink.
It is particularly designed for use as audio amplifier in radio receivers, record players and portable TV sets. The usable range of supply voltage varies from 6 to 16 V, and the circuit requires a minimum number of external components.
The package has very low thermal resistance. To decrease the thermal resistance further an external heat-sink can easily be mounted by means of ordinary hardware.

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_s	Supply voltage (no signal)	22	V
V_s	Operating supply voltage	18	V
V_i*	Input voltage	-0.5 to 20	V
I_o	Output peak current	1	A
P_{tot}	Power dissipation at $T_{amb} \leq 25\,°C$	2	W
	at $T_{case} \leq 70\,°C$ (with ∞ h.s.)	3	W
T_{stg}	Storage temperature	-55 to 125	°C
T_j	Junction temperature	150	°C

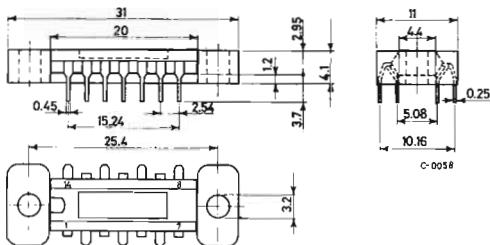
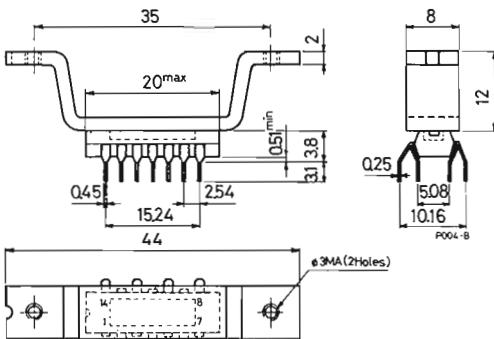
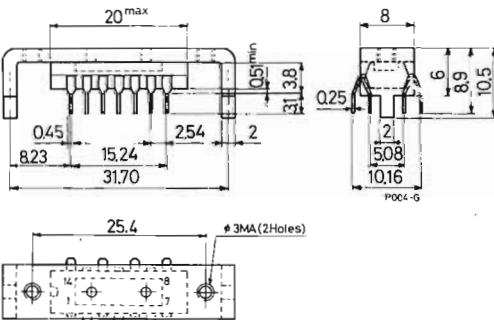
* For $V_s < 20$ V, $V_{i\,max} = V_s$.

ORDERING NUMBERS:

TAA 611 C72 (for quad in-line plastic package with spacer)
TAA 611 CX1 (for quad in-line plastic package with external bar)
TAA 611 C11 (for quad in-line plastic package with inverted external bar)

TAA 611C

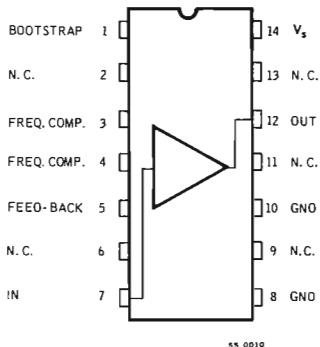
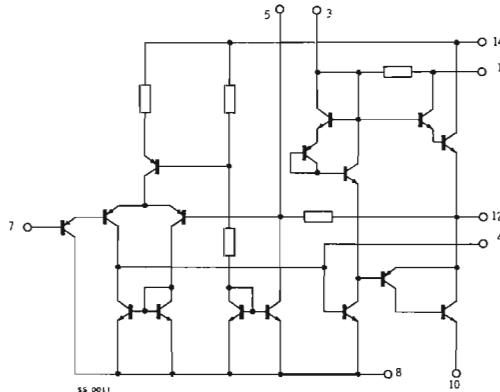
MECHANICAL DATA (Dimensions in mm)

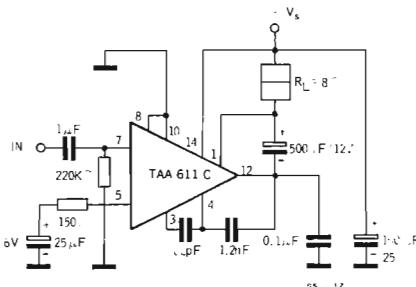
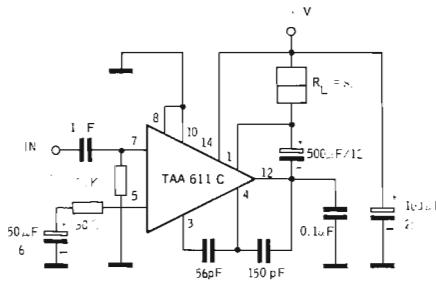
Quad in-line plastic package with spacer for TAA 611 C72 (see also "MOUNTING INSTRUCTIONS")

Quad in-line plastic package with external bar for TAA 611 CX1

Quad in-line plastic package with inverted external bar for TAA 611 C11

TAA 611C

CONNECTION DIAGRAM

(top view)

Pin	Function	Pin	Function
1	BOOTSTRAP	14	V_s
2	N.C.	13	N.C.
3	FREQ. COMP.	12	OUT
4	FREQ. COMP.	11	N.C.
5	FEED-BACK	10	GND
6	N.C.	9	N.C.
7	IN	8	GND

SS 0010

SCHEMATIC DIAGRAM

TEST CIRCUITS

Circuit No. 1 (G_v = 50)

Circuit No. 2 (G_v = 250)

TAA 611C

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	17	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	63	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

	Parameter	Test conditions		Min.	Typ.	Max.	Unit
V_o	Quiescent output voltage	V_s = 12 V			6.3		V
		V_s = 15 V			7.9		V
I_d	Total quiescent drain current	V_s = 12 V			3.5		mA
		V_s = 15 V			4		mA
I_d	Quiescent drain current of output transistors	V_s = 12 V			1.2		mA
		V_s = 15 V			1.8		mA
I_d	Drain current	V_s = 12 V, R_L = 8 Ω	P_o = 2.1 W		235		mA
		V_s = 15 V, R_L = 8 Ω	P_o = 3.3 W		300		mA
I_b	Input bias current	V_s = 12 V			75		nA
		V_s = 15 V			95		nA
P_o*	Output power	d = 2%					
		V_s = 9 V	R_L = 4 Ω		1.4		W
		V_s = 9 V	R_L = 8 Ω		0.9		W
		V_s = 12 V	R_L = 8 Ω		1.7		W
		V_s = 15 V	R_L = 8 Ω		2.8		W
		V_s = 15 V	R_L = 16 Ω		1.6		W
		d = 10%					
		V_s = 9 V	R_L = 4 Ω		1.8		W
		V_s = 9 V	R_L = 8 Ω		1.15		W
		V_s = 12 V	R_L = 8 Ω		2.1		W
		V_s = 15 V	R_L = 8 Ω	2.5	3.3		W
		V_s = 15 V	R_L = 16 Ω		1.9		W

* External heat-sink not required except for the conditions V_s = 15 V, R_L = 8 Ω.

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions		Min.	Typ.	Max.	Unit
R'_f	Internal feedback resistance (see schematic diagram)				7.5		Ω
Z_i	Input impedance	open loop			0.75		MΩ
d	Distortion	Circuit No. 1					
		$R_L = 8\ \Omega$	$f = 1$ kHz				
		$V_s = 12$ V	$P_o = 50$ mW		0.3		%
		$V_s = 15$ V	$P_o = 50$ mW		0.3		%
		$V_s = 12$ V	$P_o = 1$ W		0.2		%
		$V_s = 15$ V	$P_o = 1$ W		0.2		%
		Circuit No. 2					
		$R_L = 8\ \Omega$	$f = 1$ kHz				
		$V_s = 12$ V	$P_o = 50$ mW		1.5		%
		$V_s = 15$ V	$P_o = 50$ mW		1.5		%
		$V_s = 12$ V	$P_o = 1$ W		1		%
		$V_s = 15$ V	$P_o = 1$ W		1		%
G_v	Voltage gain (open loop)	$V_s = 12$ V	$R_L = 8\ \Omega$		70		dB
		$V_s = 15$ V	$R_L = 8\ \Omega$		72		dB

Fig. 1 - Typical distortion vs output power

Fig. 2 - Typical distortion vs output power

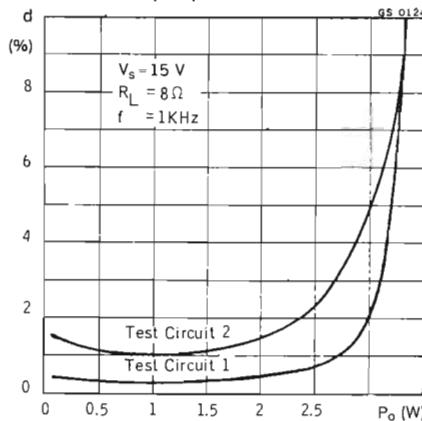



Fig. 3 - Typical distortion vs output power

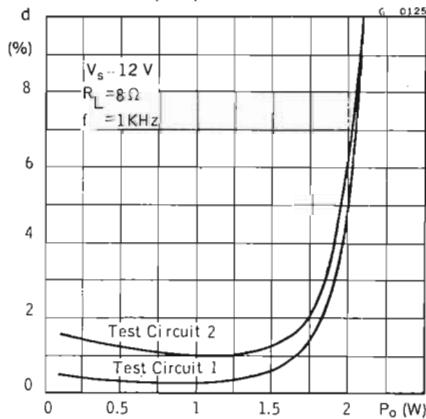



Fig. 4 - Typical output power vs load resistance

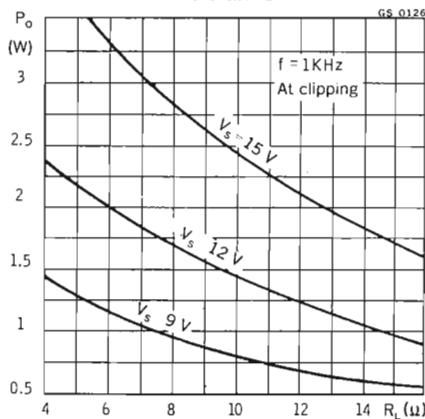



Fig. 5 - Typical output power vs load resistance

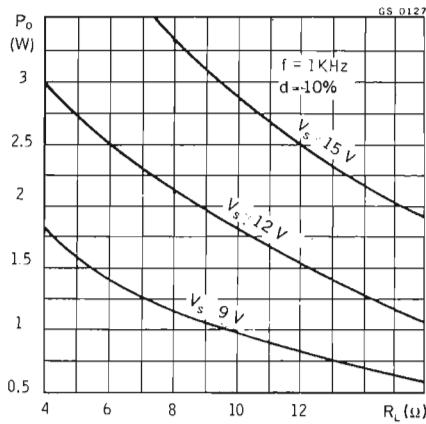



Fig. 6 - Maximum power dissipation vs load resistance

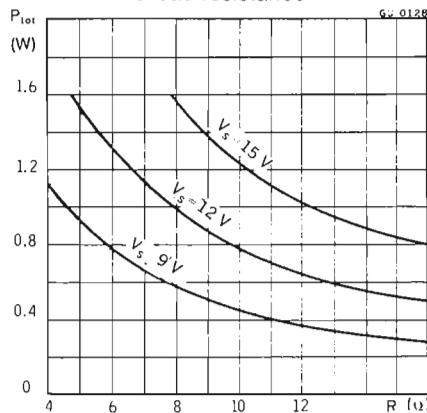



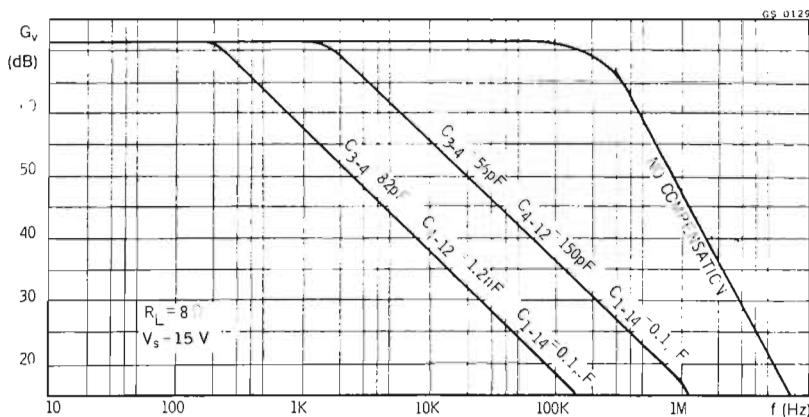
Fig. 5 - Typical voltage gain (open loop) vs frequency

TAA 611C

Fig. 8 - Typical relative frequency response

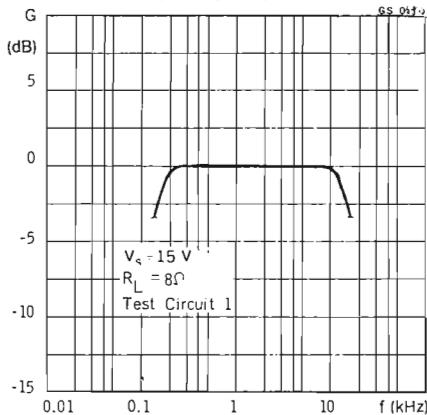



Fig. 9 - Typical relative frequency response

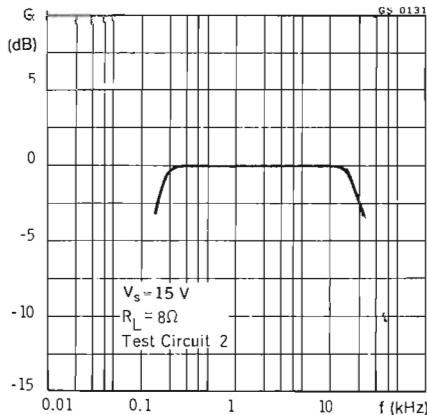



Fig. 10 - Typical output power vs input voltage

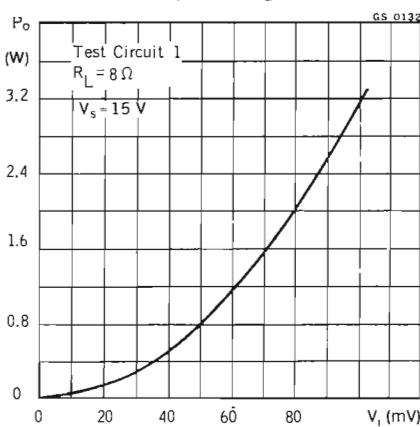



Fig. 11 - Typical output power vs input voltage

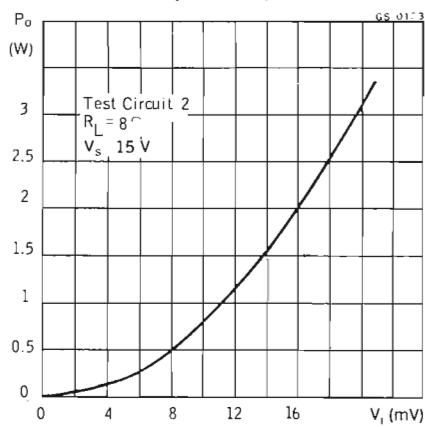



Fig. 12 - Typical power dissipation and efficiency vs output power

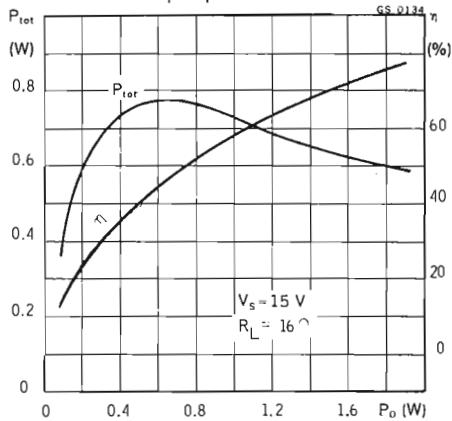



Fig. 13 - Typical power dissipation and efficiency vs output power

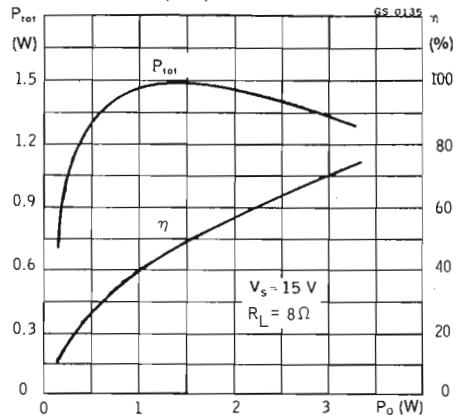



Fig. 14 - Typical power dissipation and efficiency vs output power

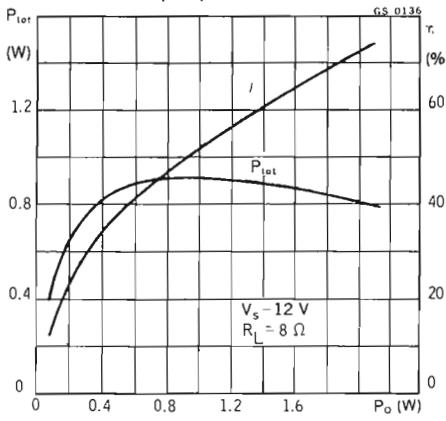



Fig. 15 - Typical power dissipation and efficiency vs output power

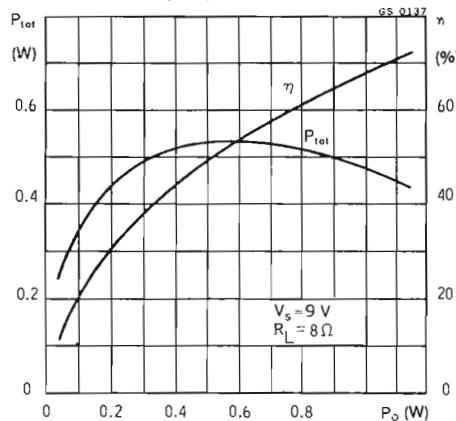



Fig. 16 - Typical drain current vs output power

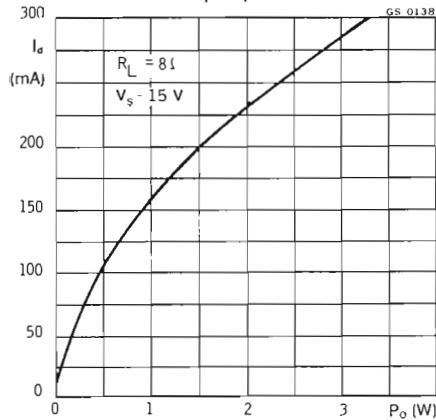



Fig. 17 - Typical quiescent drain current vs supply voltage

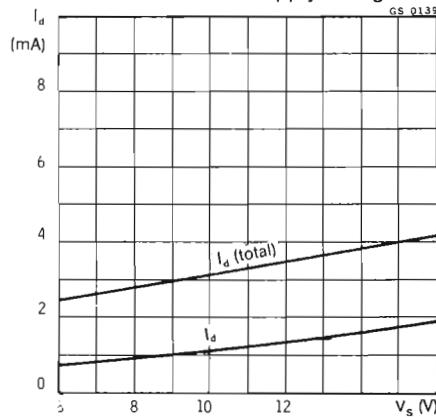



Fig. 18 - Typical total quiescent drain current vs ambient temperature

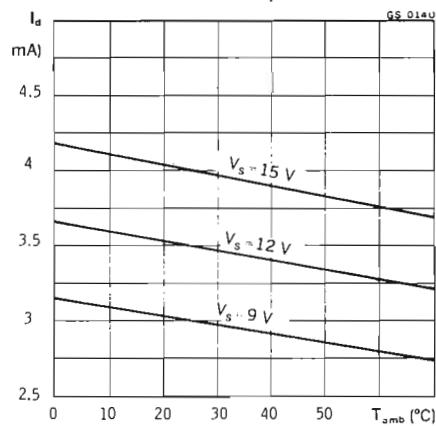



Fig. 19 - Typical quiescent drain current of output transistors vs ambient temperature

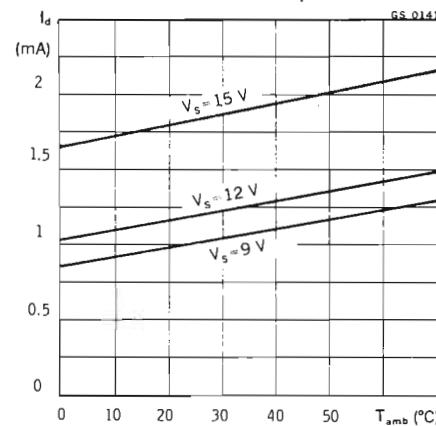



Fig. 20 - Typical output voltage variation vs ambient temperature

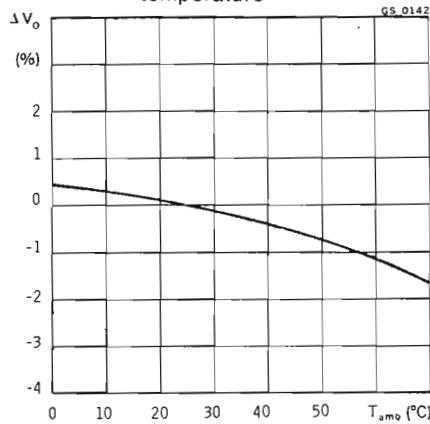



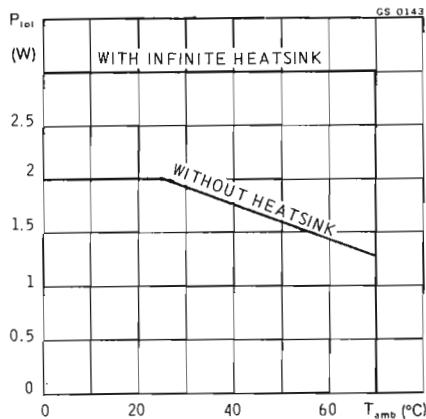
Fig. 21 - Power rating chart

TYPICAL APPLICATIONS

Fig. 22 - Audio amplifier for radio

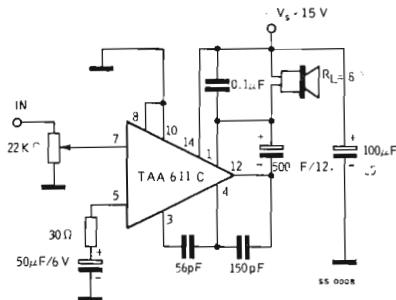
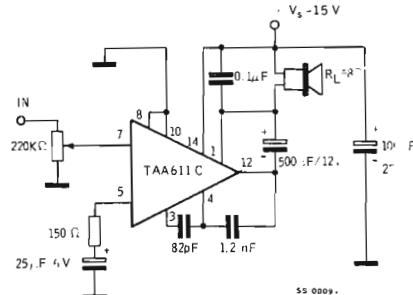
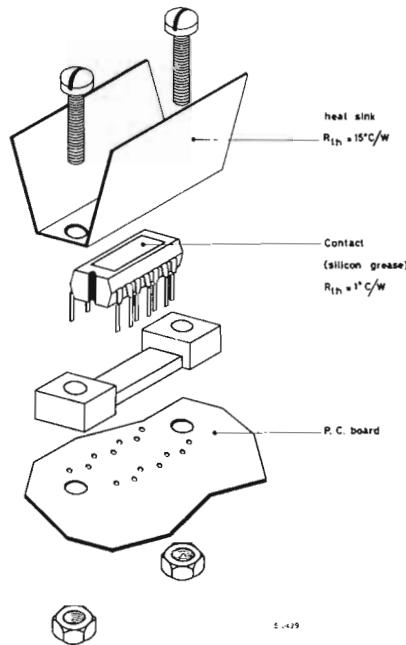



Fig. 23 - Audio amplifier for record-player

MOUNTING INSTRUCTIONS

Heat-sinking with spacer.

Fig. 24 shows a method of mounting the TAA 611C with the spacer, satisfactory both mechanically and from the point of view of heat dissipation. Better thermal contact between package and heat-sink can be obtained by using a small quantity of silicon grease. For heat dissipation the desired thermal resistance is obtained by fixing the elements shown to a heat-sink of suitable dimensions.

Fig. 24

MOUNTING INSTRUCTIONS (continued)

Heat-sinking with external bar.

Power dissipation can be achieved by means of an additional external heat-sink fixed with two screws (both packages) or by soldering the pins of the external bar to suitable copper areas on the p.c. board (TAA 611 C11).

A. In the former case, the thermal resistance case-ambient of the added heat-sink can be calculated as follows:

$$R_{th} = \frac{(T_{jmax} - T_{amb}) - P_{tot} \cdot R_{th\ j\text{-}case}}{P_{tot}}$$

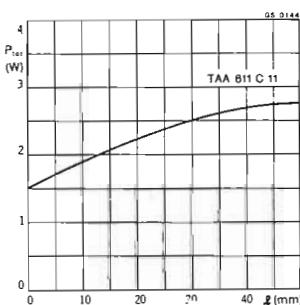
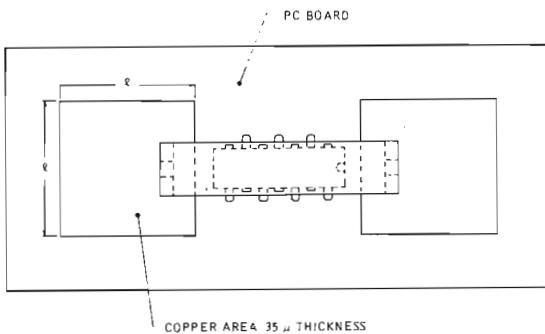
where:

T_{jmax} = Max junction temperature

T_{amb} = Ambient temperature

P_{tot} = Power dissipation

$R_{th\ j\text{-}case}$ = Thermal resistance junction-case

B. If copper areas on the p.c. board are used (TAA 611 C11) the diagrams enclosed give the maximum power dissipation as a function of copper area, with copper thickness 35 μ and ambient temperature 55 °C.

TAA 621

LINEAR INTEGRATED CIRCUIT

AUDIO AMPLIFIER

- OUTPUT POWER 4 W (24 V - 16 Ω)
- SELF CENTERING BIAS
- LOW QUIESCENT OUTPUT CURRENT
- NO CROSS OVER DISTORTION
- HIGH EFFICIENCY

The TAA 621 is an integrated monolithic circuit in a 14-lead quad in-line plastic package with external heat-sink. It is particularly designed for use in television sets as audio amplifier.
Special features of the circuit include:
— Self centering bias for any supply voltage from 6 to 24 V.
— Direct coupled input, high input impedance and high supply voltage rejection ratio.
— Minimum number of external components.
The package has very low thermal resistance. To decrease the thermal resistance further, an external heat-sink can easily be mounted by means of ordinary hardware.

ABSOLUTE MAXIMUM RATINGS

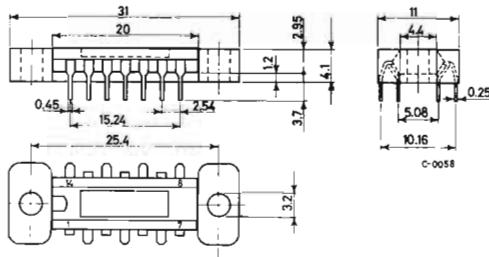
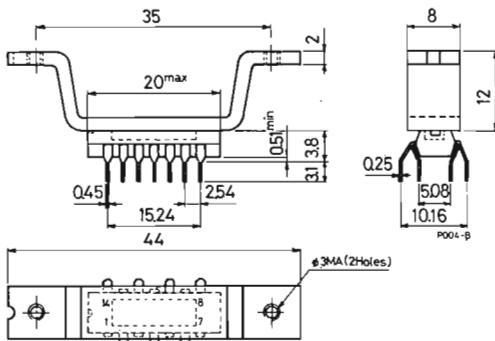
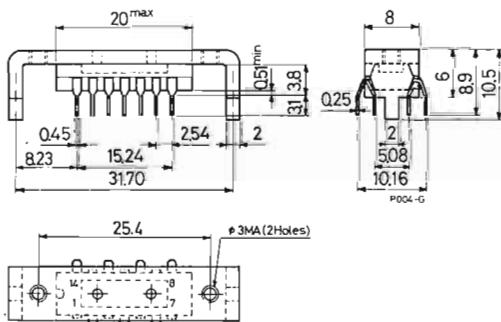
V_s	Supply voltage	27	V
V_i*	Input voltage	0.5 to 27	V
I_o	Output peak current	1	A
P_{tot}	Power dissipation at $T_{amb} = 25\,°C$	2	W
	at $T_{case} = 70\,°C$	4.5	W
T_{stg}, T_j	Storage and junction temperature	-55 to 150	°C

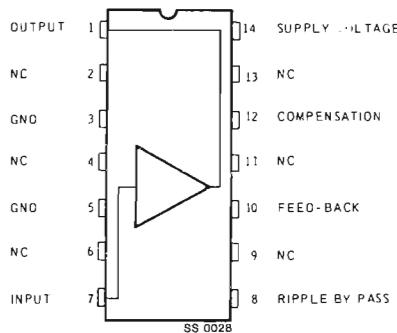
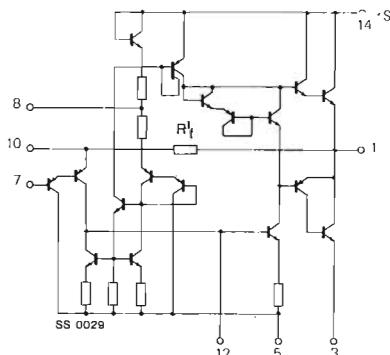
* For $V_s < 27$ V, $V_{i\,max} = V_s$.

ORDERING NUMBERS:

TAA 621 A72 (for quad in-line plastic package with spacer)
TAA 621 AX1 (for quad in-line plastic package with external bar)
TAA 621 A11 (for quad in-line plastic package with inverted external bar)

TAA 621

Quad in-line plastic package with spacer for TAA 621 A72 (see also "MOUNTING INSTRUCTIONS")

Quad in-line plastic package with external bar for TAA 621 AX1

Quad in-line plastic package with inverted external bar for TAA 621 A11

TAA 621

CONNECTION DIAGRAM
(top view)

The heat-sink is connected to the substrate (pin 5)

SCHEMATIC DIAGRAM

TEST CIRCUIT

TAA 621

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	17	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	63	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

	Parameter	Test conditions		Min.	Typ.	Max.	Unit
I_d	Total quiescent drain current	V_s = 18 V			6.2		mA
		V_s = 24 V			7.5		mA
I_d	Quiescent drain current of output transistors	V_s = 18 V			2.5		mA
		V_s = 24 V			3		mA
I_d	Drain current	d = 10%	R_L = 16 Ω				
		P_o = 2.2 W	V_s = 18 V		175		mA
		P_o = 4 W	V_s = 24 V		220		mA
I_b	Input bias current	V_s = 18 V			180		nA
		V_s = 24 V			250		nA
P_o*	Output power	d = 3%					
		V_s = 18 V	R_L = 16 Ω		1.7		W
		V_s = 24 V	R_L = 16 Ω		2.7		W
		d = 10%					
		V_s = 18 V	R_L = 16 Ω		2.2		W
		V_s = 24 V	R_L = 16 Ω	3	4		W
R'_f	Internal feedback resistance (see schematic diagram)				15		kΩ
Z_i	Input impedance	V_s = 18 V			150		kΩ
		V_s = 24 V			110		kΩ
d	Distortion	P_o = 50 mW					
		f = 1 kHz					
		R_L = 16 Ω					
		V_s = 18 V			0.1		%
		V_s = 24 V			0.1		%
G_v	Voltage gain	open loop	R_L = 16 Ω				
		V_s = 18 V			72		dB
		V_s = 24 V			74		dB

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
SVR	Supply voltage rejection	$R_L = 16\ \Omega$ f(ripple) = 100 Hz $C_6 = 100\ \mu f$(see application circuit diagrams)				
		$V_s = 18$ V		52		dB
		$V_s = 24$ V		52		dB
		$C_6 = 50\ \mu F$				
		$V_s = 18$ V		46		dB
		$V_s = 24$ V		46		dB

* External heat-sink not required except for the conditions $V_s = 24$ V, $R_L = 16\ \Omega$.

Fig. 1 - Typical output power vs supply voltage

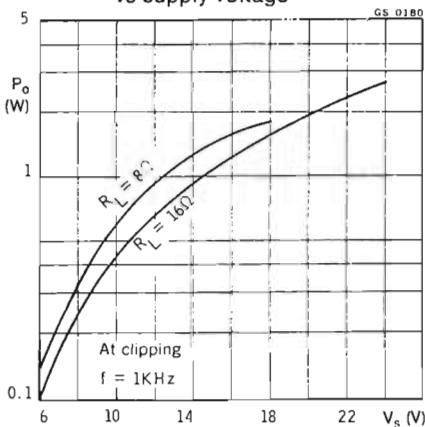



Fig. 2 - Typical output power vs supply voltage

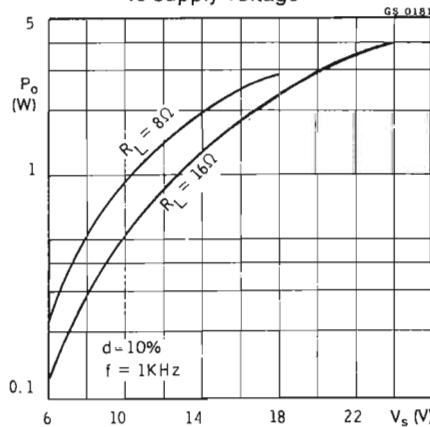



Fig. 3 - Typical distortion vs output power

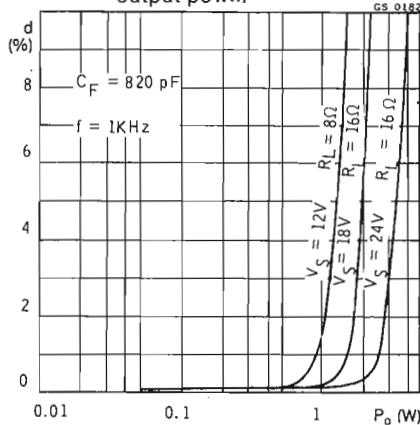



Fig. 4 - Typical relative frequency response

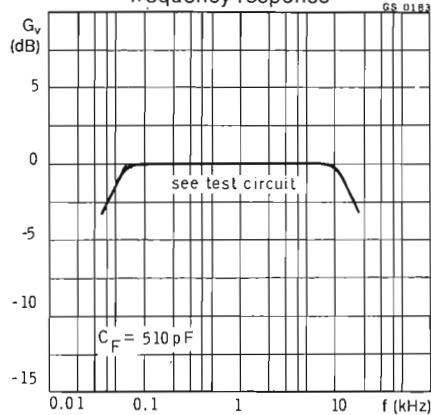



Fig. 5 - Typical relative frequency response

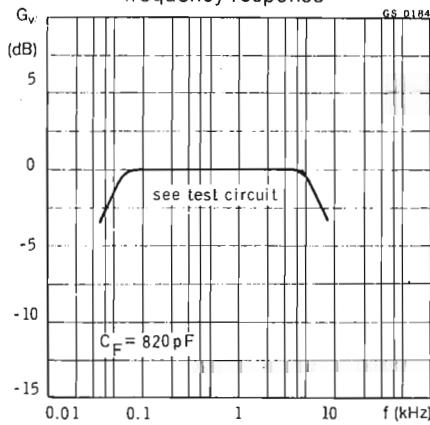



Fig. 6 - Typical open loop voltage gain vs frequency

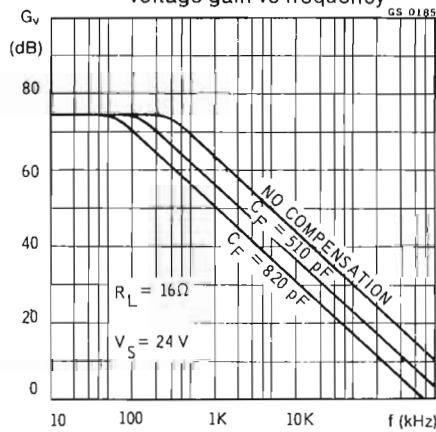



Fig. 7 - Typical output power vs input voltage

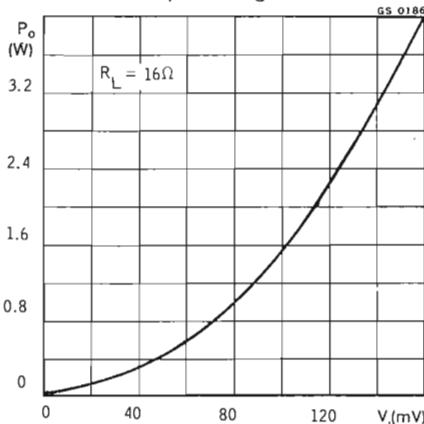



Fig. 8 - Typical output power vs input voltage

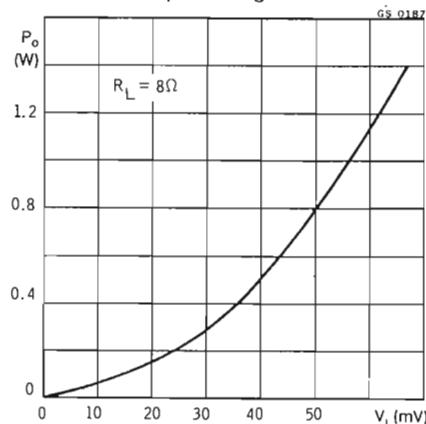



Fig. 9 - Typical power dissipation and efficiency vs output power

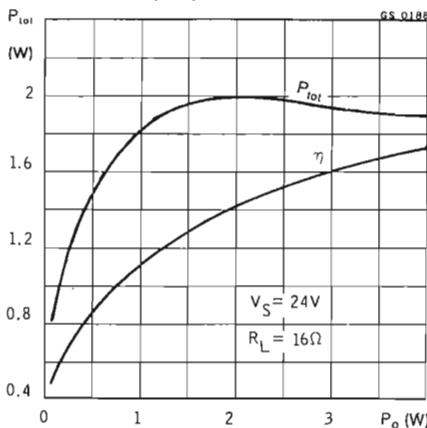



Fig. 10 - Typical power dissipation and efficiency vs output power

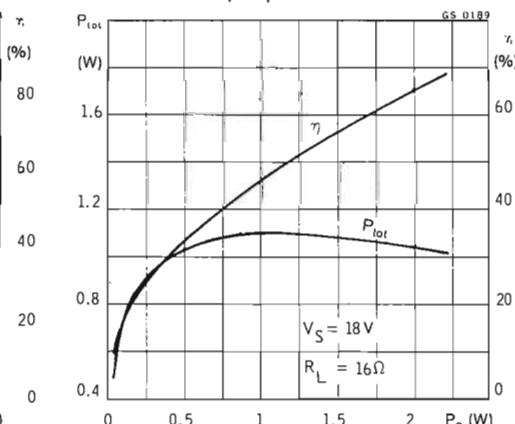



Fig. 11 - Typical power dissipation and efficiency vs output power

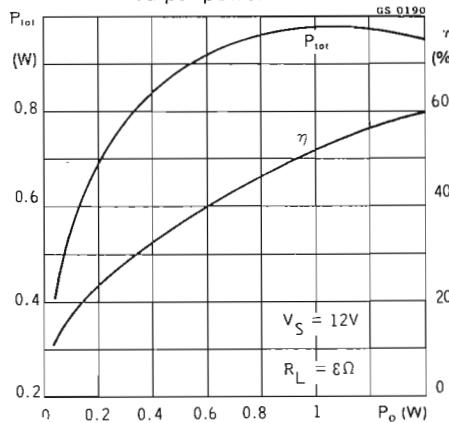



Fig. 12 - Typical drain current vs output power

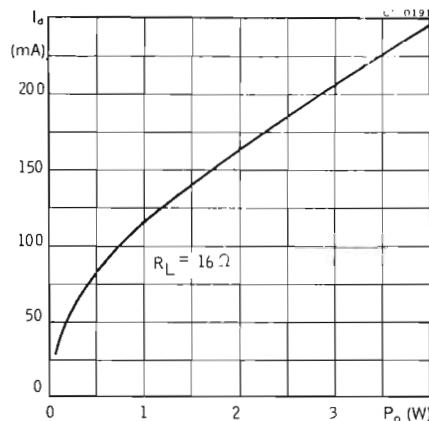



Fig. 13 - Typical drain current vs output power

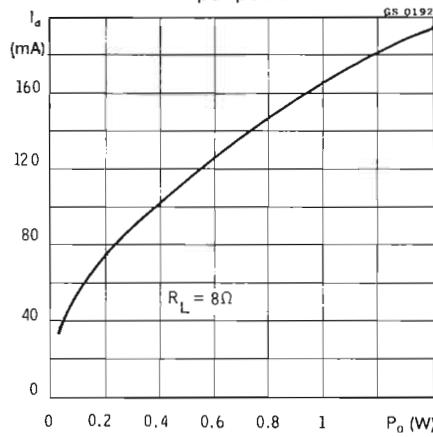



Fig. 14 - Maximum power dissipation vs supply voltage

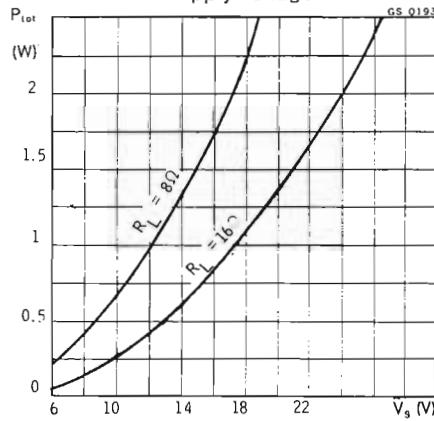



Fig. 15 - Typical quiescent drain current vs supply voltage

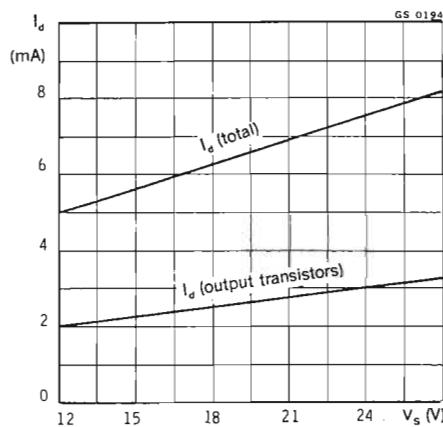



Fig. 16 - Typical total quiescent drain current vs ambient temperature

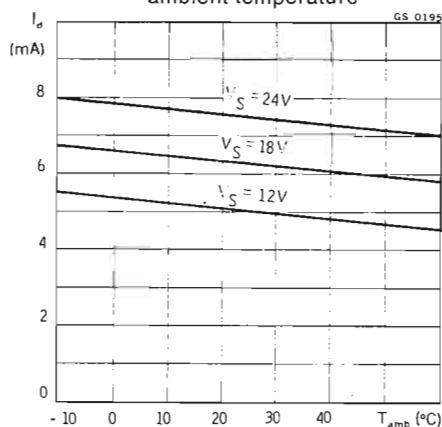



Fig. 17 - Typical quiescent drain current of output transistors vs ambient temperature

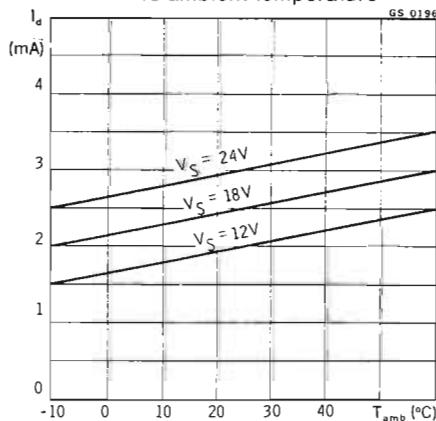



Fig. 18 - Typical relative DC output level vs ambient temperature

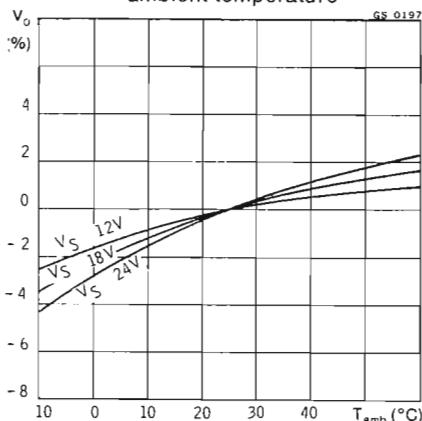



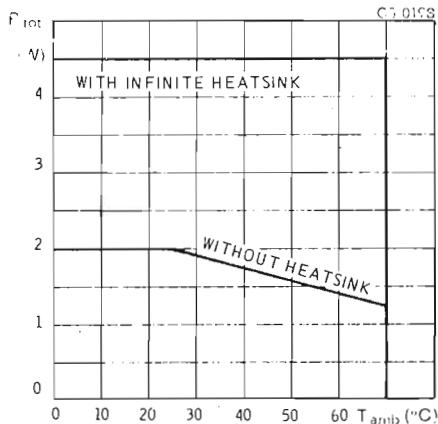
Fig. 19 - Power rating chart

TYPICAL APPLICATIONS

Fig. 20 - Record player

TAA 621
220KΩ
250 μF/25
0.1μF
C_F *
R_L
SS 0031

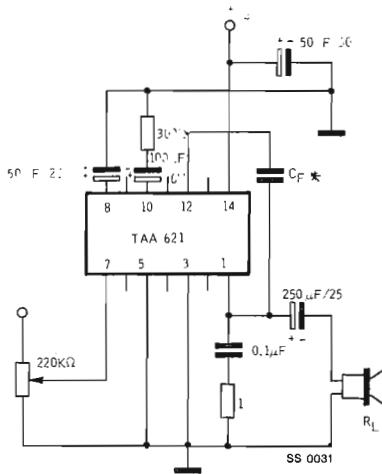
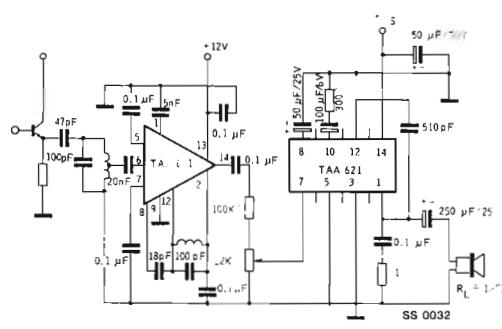
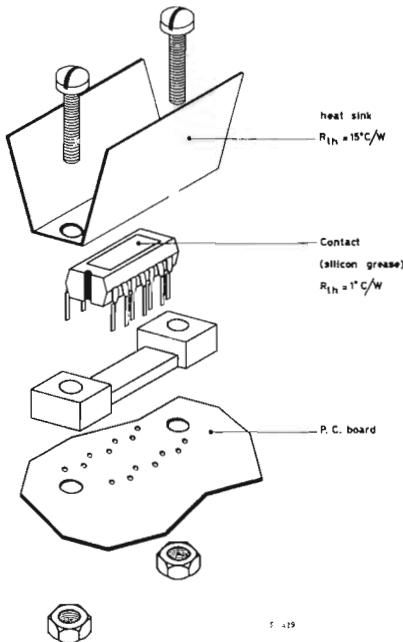



Fig. 21 - Complete TV sound section

*C_F see figs. 4 and 5.

MOUNTING INSTRUCTIONS

Heat-sinking with spacer.

Fig. 22 shows a method of mounting the TAA 621 with the spacer, satisfactory both mechanically and from the point of view of heat dissipation. Better thermal contact between package and heat-sink can be obtained by using a small quantity of silicon grease. For heat dissipation the desired thermal resistance is obtained by fixing the elements shown to a heat-sink of suitable dimensions.

Fig. 22

MOUNTING INSTRUCTIONS (continued)

Heat-sinking with external bar

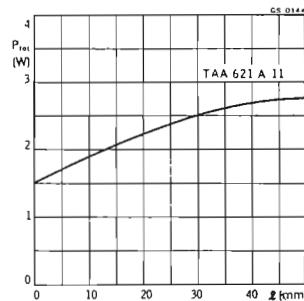
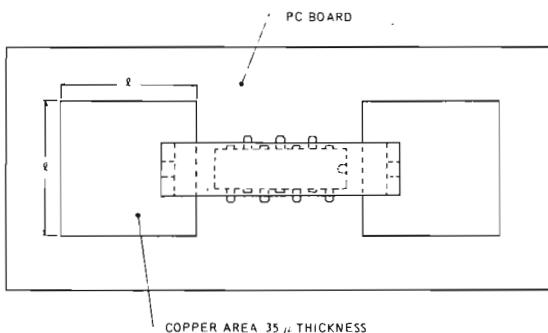
Power dissipation can be achieved by means of an additional external heat-sink fixed with two screws (both packages) or by soldering the pins of the external bar to suitable copper areas on the p.c. board (TAA 621 A11).

A. In the former case, the thermal resistance case-ambient of the added heat-sink can be calculated as follows:

$$R_{th} = \frac{(T_{jmax} - T_{amb}) - P_{tot} \cdot R_{th\ j\text{-}case}}{P_{tot}}$$

where:

T_{jmax} = Max junction temperature
T_{amb} = Ambient temperature
P_{tot} = Power dissipation
$R_{th\ j\text{-}case}$ = Thermal resistance junction-case

B. If copper areas on the p.c. board are used (TAA 621 A11) the diagrams enclosed give the maximum power dissipation as a function of copper area, with copper thickness 35 μ and ambient temperature 55 °C.

TAA 630S

LINEAR INTEGRATED CIRCUIT

PRELIMINARY DATA

SYNCHRONOUS DEMODULATOR FOR PAL COLOUR TV SETS

The TAA 630 S is a silicon monolithic integrated circuit in a 16-lead dual in-line plastic package. It incorporates the following functions:

— active synchronous demodulators for F (B-Y) and ± F (R-Y) signals
— matrix for G-Y signal [G-Y = -0.51 (R-Y) -0.19 (B-Y)]
— flip-flop
— PAL switch and colour killer.

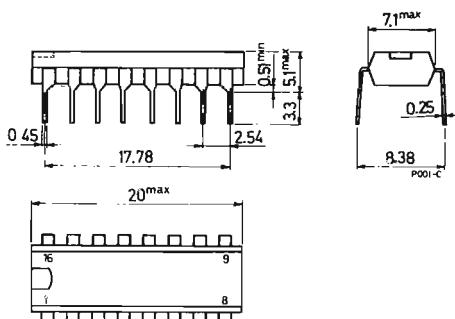
It is intended for PAL colour television receivers employing colour difference output stages with clamping circuits.

ABSOLUTE MAXIMUM RATINGS

V_s	Supply voltage (between pins 6 and 16 - see note)	13.2	V
V_1	Reverse identification input voltage	-5	V
I_1	Identification input current	1	mA
I_o	Output current (from pins 4, 5 and 7)	5	mA
P_{tot}	Total power dissipation: at $T_{amb} \leq 50\,°C$ (see note)	550	mW
T_{stg}	Storage temperature	-20 to 125	°C
T_{op}	Operating temperature	-20 to 60	°C

NOTE: $V_s = 16$ V and $P_{tot} = 800$ mW (at $T_{amb} \leq 50\,°C$) are permissible during warm up time of tubes in mixed sets.

MECHANICAL DATA

Dimensions in mm

TAA 630S

ELECTRICAL CHARACTERISTICS

(measured using the test circuit of fig. 3 at T_{amb} = 25 °C)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
STATIC (DC) CHARACTERISTICS						
I_1	Input current for identification circuit ON	$V_{10} \geq 0.9$ V	80			μA
V_1	Input voltage for identification circuit ON	$V_{10} \geq 0.9$ V	0.75			V
V_1	Input voltage for identification circuit OFF	$V_{10} \geq 0.9$ V			0.4	V
V_4*	DC voltage at (R-Y) output	$V_{10} \geq 0.9$ V		see note		V
V_5*	DC voltage at (G-Y) output	$V_{10} \geq 0.9$ V		see note		V
V_7	DC voltage at (B-Y) output	$V_{10} \geq 0.9$ V		7.3		V
V_{10}	Killer input voltage for colour ON		0.9			V
V_{10}	Killer input voltage for colour OFF				0.3	V
DYNAMIC CHARACTERISTICS						
V_1	Peak to peak identification input voltage	$V_{10} \geq 0.9$ V f = 7.8 kHz		4		V
V_3	Peak to peak flip-flop output voltage	$V_{10} \geq 0.9$ V f = 7.8 kHz		2.5		V
V_4	R-Y output voltage swing	$V_{10} \geq 0.9$ V f = 4.4 MHz Linearity m $\geq$ 0.7			3.2	V
V_5	G-Y output voltage swing	$V_{10} \geq 0.9$ V f = 4.4 MHz Linearity m $\geq$ 0.7			1.8	V
V_7	B-Y output voltage swing	$V_{10} \geq 0.9$ V f = 4.4 MHz Linearity m $\geq$ 0.7			4	V

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
V_2**	R-Y reference input voltage	$V_{10} \geq 0.9$ V f = 4.4 MHz		1		V
V_8**	B-Y reference input voltage			1		V
V_{14}	Peak flip-flop input voltage	$V_{10} \geq 0.9$ V f = 15.6 kHz	-2.5		-5	V
V_{15}	Peak flip-flop input voltage		-2.5		-5	V
V_4/V_{13}***	R-Y demodulator gain	$V_{10} \geq 0.9$ V f = 4.4 MHz V_i (peak to peak) = 50 mV		7		—
$\frac{V_7}{V_9} \cdot \frac{V_{13}}{V_4}$	B-Y demodulator gain to R-Y demodulator gain ratio			1.78		—
R_9	Parallel input resistance at pin 9	$V_{10} \geq 0.9$ V f = 4.4 MHz V_i = 20 mV	800			Ω
C_9	Parallel input capacitance at pin 9				10	pF
R_{13}	Parallel input resistance at pin 13		800			Ω
C_{13}	Parallel input capacitance at pin 13				10	pF
$\|Z_4\|$	R-Y output impedance	$V_{10} \geq 0.9$ V			100	Ω
$\|Z_5\|$	G-Y output impedance				100	Ω
$\|Z_7\|$	B-Y output impedance				100	Ω
$\|Z_2\|$	Parallel input impedance at pin 2	$V_{10} \geq 0.9$ V f = 4.4 MHz V_i = 400 mV		900		Ω
$\|Z_8\|$	Parallel input impedance at pin 8			900		Ω

NOTES: * Adjustable to the same level of V_7 by variable resistors, or by variable voltages ≤ 1.2 V, connected between pins 11 and 16 for V_4 and between pins 12 and 16 for V_5.

** Maximum permissible range : 0.5 to 2 V (peak to peak).

*** Peak to peak output voltage to peak to peak input voltage ratio.

TAA 630S

Fig. 1 - Schematic diagram

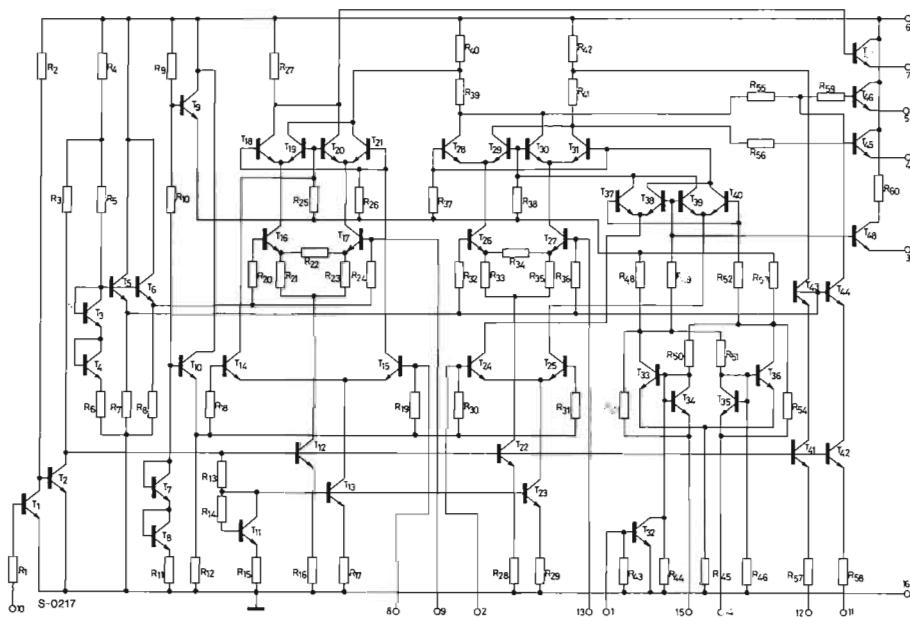



Fig. 2 - Power rating chart

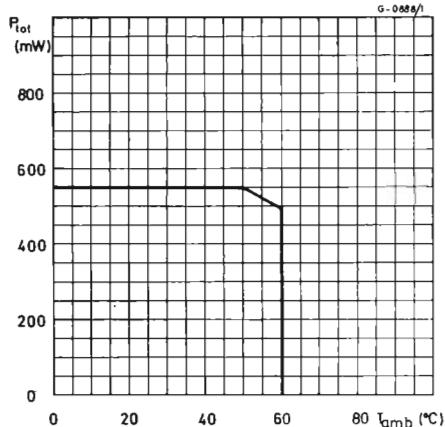
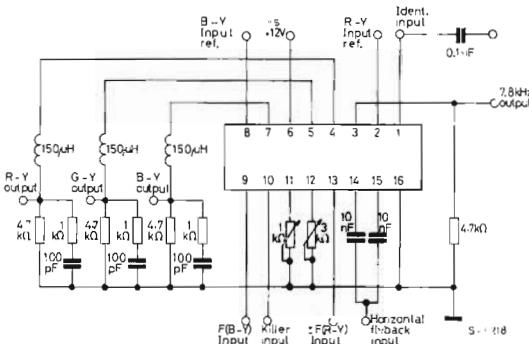
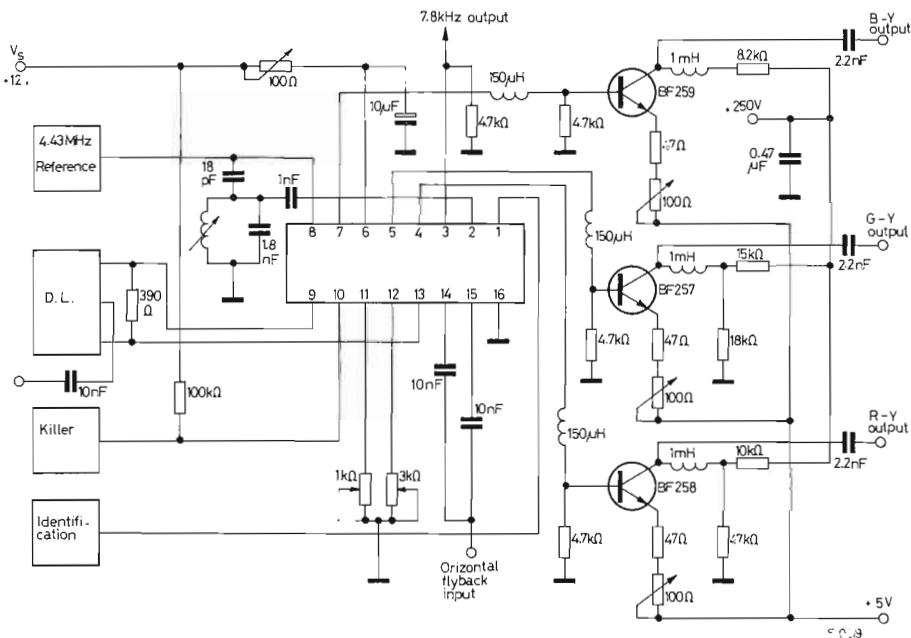



Fig. 3 - Test circuit

Fig. 4 - Typical application circuit

LINEAR INTEGRATED CIRCUIT

TAA 661

FM IF AMPLIFIER-LIMITER AND DETECTOR

- HIGH GAIN
- FREQUENCY RANGE 5 kHz to 60 MHz
- THRESHOLD LIMITING VOLTAGE 100 μV (5.5 MHz)
- COINCIDENCE GATE DETECTOR
- AUDIO OUTPUT VOLTAGE 1.4 Vrms (d = 1%)

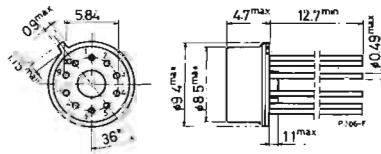
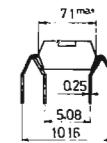
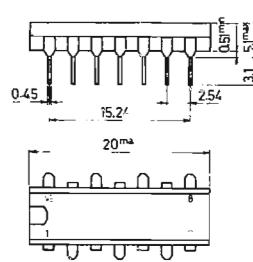
The TAA 661 is a monolithic integrated circuit in a 14-lead quad in-line plastic package or in a Jedec TO-100 metal case. Particularly designed for use in TV sound IF or FM IF amplifiers, it includes: a limiter amplifier, a coincidence detector and a voltage regulator. By using the TAA 661 the ratio detector transformer is eliminated and the audio signal is capable of driving an output amplifier directly. Detector alignment is obtained by adjusting a single coil wich provides the quadrature signal to the coincidence gate detector.

ABSOLUTE MAXIMUM RATINGS

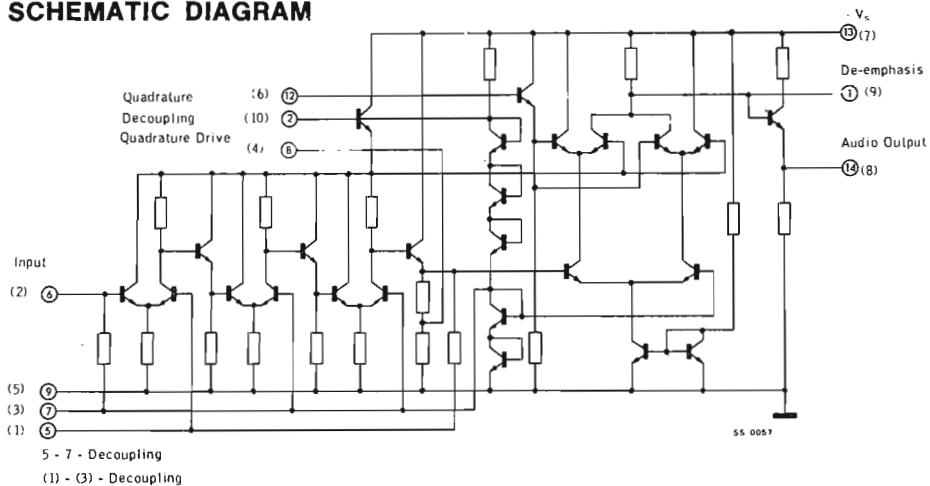
V_s	Supply voltage		15 V
P_{tot}	Power dissipation at $T_{amb} \leq 70$ °C	for **TAA 661 A55**	350 mW
		for **TAA 661 BX2**	500 mW
T_{stg}	Storage temperature		-25 to 125 °C
T_{op}	Operating temperature		0 to 70 °C

ORDERING NUMBERS: TAA 661 A55 (for TO-100 metal case)
TAA 661 BX2 (for 14-lead quad in-line plastic package)

MECHANICAL DATA

Dimensions in mm

TAA 661 A55

TAA 661 BX2

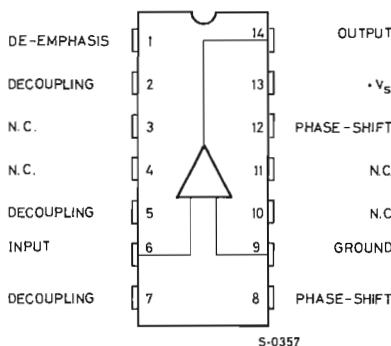
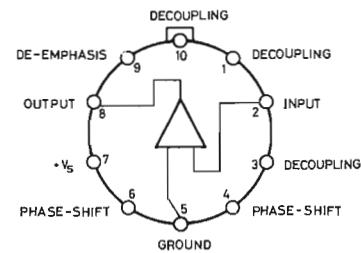
TAA 661

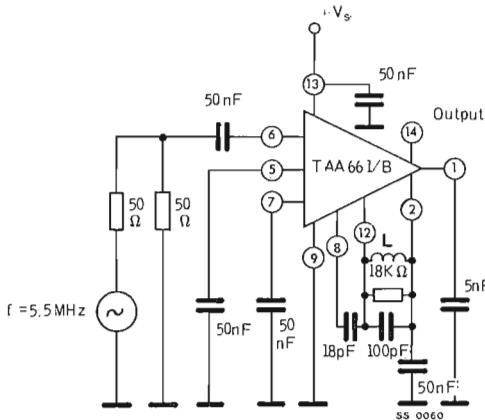
SCHEMATIC DIAGRAM

NOTE: the number in brackets refers to the TO-100 package.

CONNECTION DIAGRAMS (top views)

For **TAA 661 BX2**

Function	Pin	Pin	Function
DE-EMPHASIS	1	14	OUTPUT
DECOUPLING	2	13	+Vs
N.C.	3	12	PHASE-SHIFT
N.C.	4	11	N.C.
DECOUPLING	5	10	N.C.
INPUT	6	9	GROUND
DECOUPLING	7	8	PHASE-SHIFT

S-0357

For **TAA 661 A55**

TAA 661

TEST CIRCUIT

L = 35 turns of 0.16 mm nylon covered copper wire.

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_d	Quiescent drain current	V_s = 6 V V_s = 9 V V_s = 12 V	9 11 13		14 17 20	mA mA mA
$V_{i(threshold)}$	Input limiting voltage	f = 5.5 MHz f = 10.7 MHz		100 230		μV μV
V_o	Recovered output voltage	V_i = 10 mV f = 5.5 MHz f_m = 1 kHz Δf = ±50 kHz V_s = 6 V V_s = 9 V V_s = 12 V		0.5 0.75 1.4		V_{rms} V_{rms} V_{rms}
d	Distortion	V_s = 12 V V_i = 10 mV f = 5.5 MHz f_m = 1 kHz Δf = ±25 kHz		1		%

ELECTRICAL CHARACTERISTICS (continued)

	Parameter	Test conditions	Min. Typ. Max.	Unit
AMR	Amplitude modulation rejection	V_s = 12 V V_i = 10 mV f = 5.5 MHz f_m = 1 kHz Δf = ±50 kHz m = 0.3	45	dB
R_i	Input resistance	f = 5.5 MHz f = 10.7 MHz	2.5 2	kΩ kΩ
C_i	Input capacitance	V_s = 9 V f = 5.5 MHz	2.5	pF
Z_o	Output impedance	V_s = 6 V V_s = 9 V V_s = 12 V	200 150 100	Ω Ω Ω
R_L	Min. load impedance without clipping	V_s = 6 V V_s = 9 V V_s = 12 V	10 4 2	kΩ kΩ kΩ
R_{5-6}	Resistance between pins 5 and 6 of the TAA 661 A55	f = 5.5 MHz V_s = 6 V V_s = 9 V V_s = 12 V	50 50 50	kΩ kΩ kΩ
C_{5-6}	Capacitance between pins 5 and 6 of the TAA 661 A55	f = 5.5 MHz	3	pF

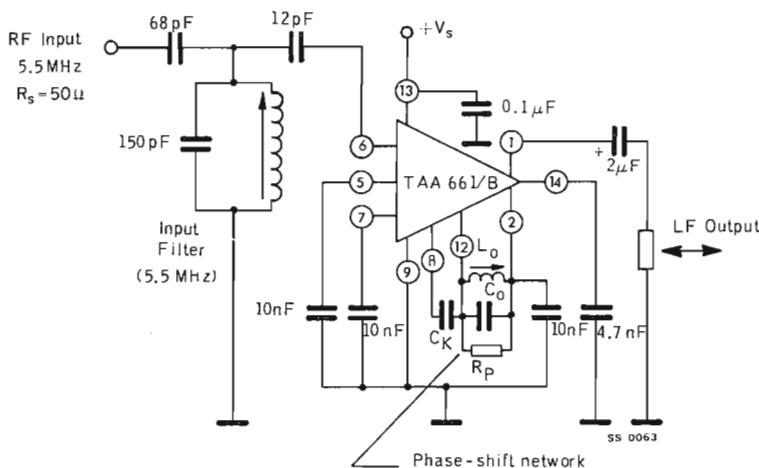
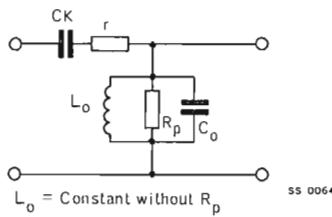
TAA 661 AS TV SOUND IF AMPLIFIER (outputs referred to the TAA 661 BX2)

PHASE SHIFT NETWORK

	a	b	c	d	e	f
Co/pF	120	100	56	33	15	–

Fig. 1 - Typical distortion

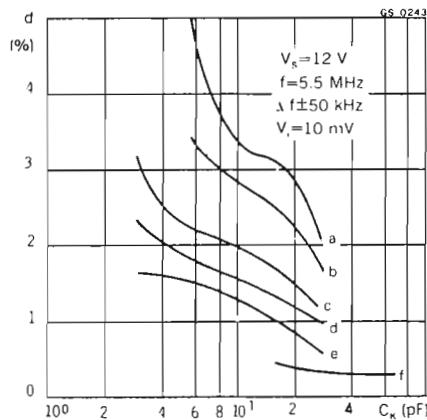



Fig. 2 - Typical amplitude modulation rejection

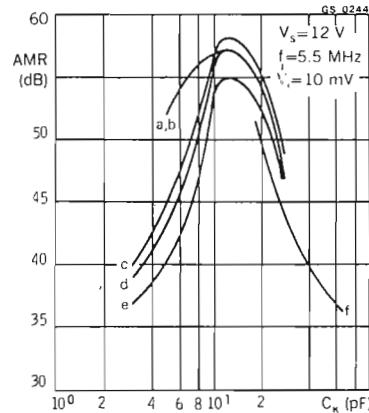



Fig. 3 - Typical amplitude modulation rejection vs input voltage

Curve	C_K/pF	C_o/pF	R_p/kΩ
1	12	3[illegible]	–
2	12	100	–
3	18	100	27
4	18	68	–

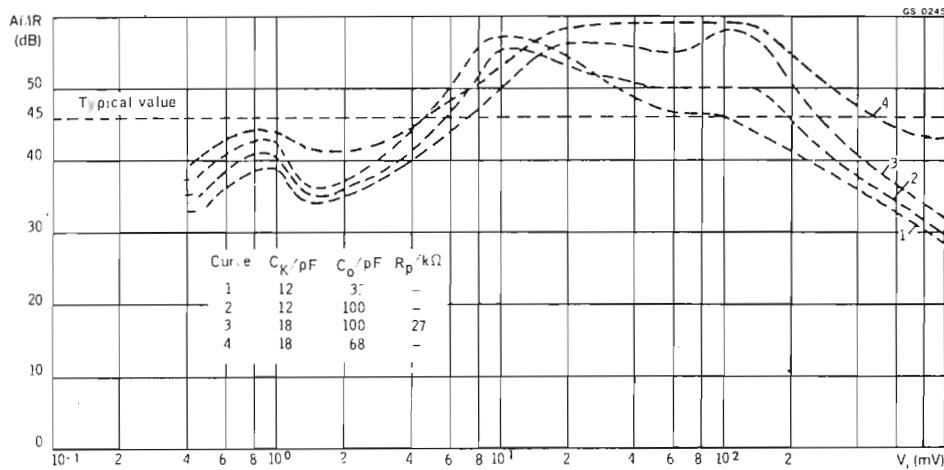



Fig. 4 - Typical recovered output voltage

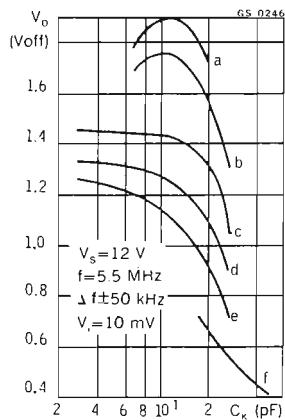
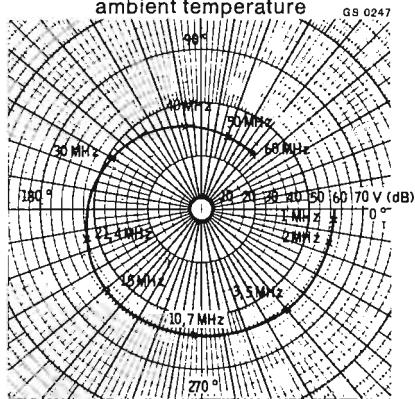
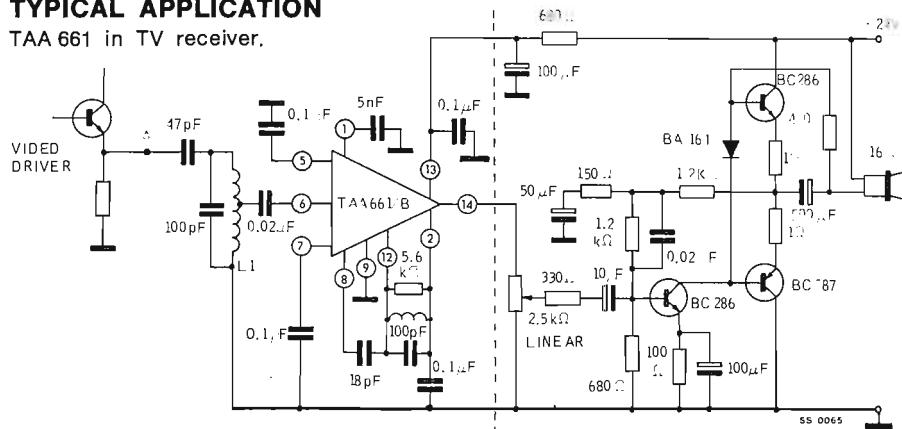



Fig. 5 - Phase response of the TAA 661 wide band amplifier measured at 25 °C ambient temperature

TYPICAL APPLICATION

TAA 661 in TV receiver.

Notes:

— Pin numbers shown are for the TAA 661 BX2.
— L_1 = 24 turns of 0.16 mm nylon covered copper wired with tapping at turn 12 from ground.
— L_2 = 35 turns of 0.16 mm nylon covered copper wired.
— Neosid former K4/21.5/0.5 - Neosid core GW4 x 0.5 x 10FE10(Q_o=80).

TAA 691

LINEAR INTEGRATED CIRCUIT

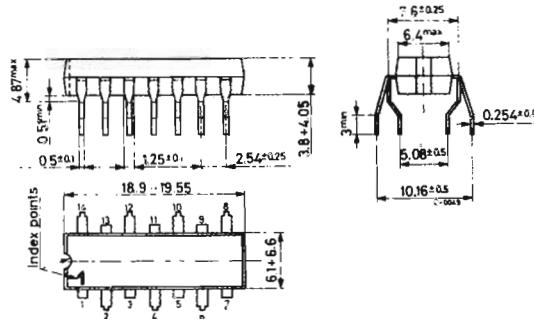
WIDE-BAND AMPLIFIER, FM DETECTOR, AUDIO PREAMPLIFIER/DRIVER

The TAA 691 provides, in a single monolithic silicon chip, a major subsystem for the sound section of TV receivers in a 14-lead quad in-line plastic package.
As shown in the schematic diagram the TAA 691 contains a multistage wide-band IF amplifier/limiter section, an FM-detector stage, a Zener-diode-regulated power-supply section and an audio-amplifier section specifically designed to drive directly any type of valve or transistor output stage.
In FM receivers, the TAA 691 can be used to provide IF amplification and limiting, FM detection and AF preamplification.
In the TAA 691, the demodulation is effected by a single tuning discriminator coils as well as a ratio detector.
The TAA 691 provides exceptional versatility of circuit design because the IF amplifier/limiter section, FM-detector section and audio-preamplifier/driver section can be used independently of each other.

ABSOLUTE MAXIMUM RATINGS

V_s	Supply voltage (at pin 6)	20	V
V_i	Input-signal voltage (between terminals 1 and 3)	±3	V
I_s	Supply current (at pin 14)	50	mA
I_o	Output current (from pin 5)	80	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25$ °C	850	mW
T_{stg}	Storage temperature	-25 to 150	°C
T_{op}	Operating temperature	0 to 85	°C

MECHANICAL DATA

Dimensions in mm

TAA 691

THERMAL DATA

$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	typ.	150	°C/W

ELECTRICAL CHARACTERISTICS* (T_{amb} = 25 °C)

Parameter		Test conditions	Min.	Typ.	Max.	Unit	Fig.
I_{11}	Bias current of third amplifier		0.25	0.63	1	mA	3
I_{14}	Supply current	V_S = 6.2 V (applied direct. to pin 14)	8	12	18	mA	3
V_{14}	Internal reference voltage		6.9	7.4	8.1	V	3
$V_{i(lim)}$	Input limiting voltage (pin 13)	f = 5.5 MHz		150	250	μV	5-6
V_o	Recovered audio voltage (pin 13)	V_i = 10 mV R_L = 50 kΩ f = 5.5 MHz f_m = 1 kHz Δf = ±50 kHz		260		mV	5
V_o	Audio output voltage (pin 5)	V_i = 10 mV R_L = 1 kΩ f = 5.5 MHz f_m = 1 kHz Δf = ±50 kHz		4		V	10
→ d	Distortion (pin 13)	V_i = 100 mV f = 5.5 MHz f_m = 1 kHz Δf = ±50 kHz		1.3		%	10
→ V_i	Input voltage (pin 7)	P_o = 1.5 W f = 1 kHz		3.2		mV	2

* DC supply voltage, V_S, of +16 V applied to terminal 14 through a resistance of [illegible]0Ω, unless otherwise indicated.

ELECTRICAL CHARACTERISTICS (continued)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit	Fig.
→ d	Distortion (on R_L)	V_s = 10.8 V P_o = 1 W f = 1 kHz Input at pin 7		1		%	2
R_i	Input resistance (pin 1)	f = 5.5 MHz		11		kΩ	4
R_i	Input resistance (pin 7)	f = 1 kHz		100		kΩ	—
R_o	Output resistance (pin 11)	f = 5.5 MHz		100		kΩ	—
R_o	Output resistance (pin 5)	f = 1 kHz		250		Ω	—
R_o	Output resistance (pin 13)	f = 1 kHz		10		kΩ	—
C_i	Input capacitance (pin 1)	f = 5.5 MHz		5		pF	4
C_o	Output capacitance (pin 11)	f = 5.5 MHz		4		pF	—
G_v	Voltage gain	f = 5.5 MHz		67		dB	8
P_{tot}	Total power dissipation		245	265	280	mW	3
→ AMR	Amplitude modulation rejection	f = 5.5 MHz	35	48		dB	5-7

TAA 691

SCHEMATIC DIAGRAM

Fig. 1

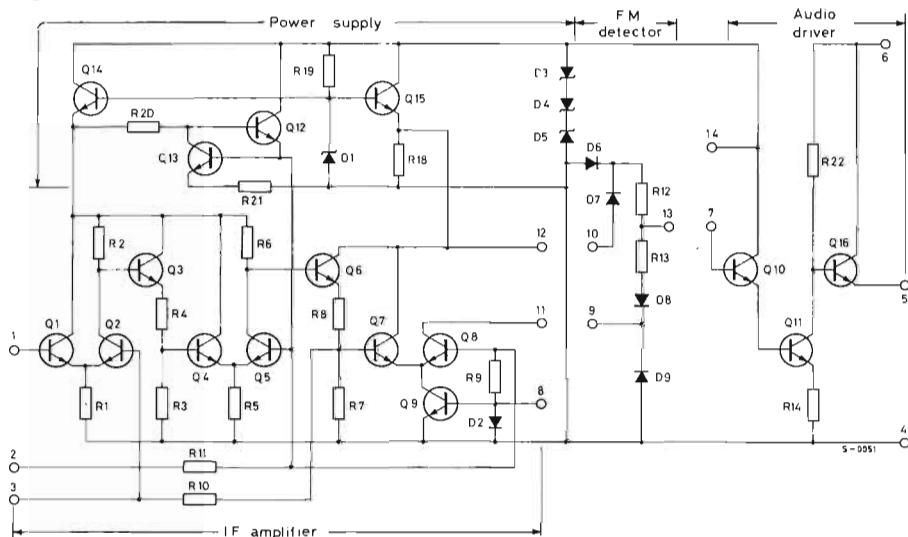
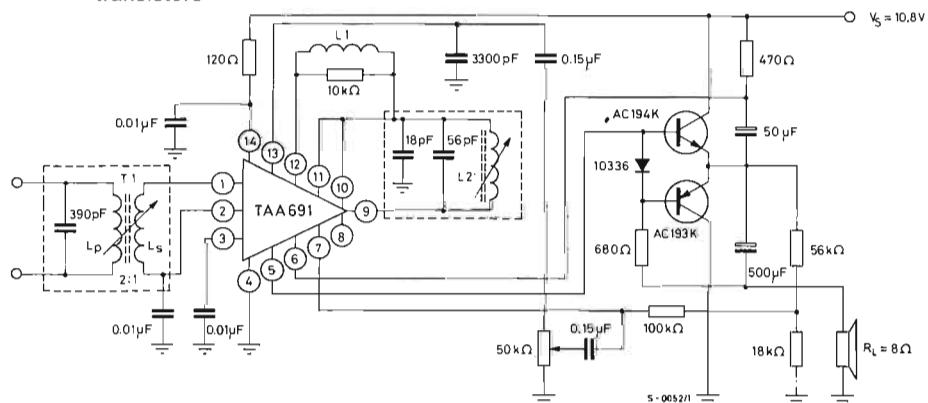



Fig. 2 - Typical circuit utilizing the TAA 691 and SGS-ATES AC 193K and AC 194K transistors

T_1 = 5.5 MHz TRANSFORMER:

L_p = 5.5 μH; Q_o = 80; 19 turns Ø 0.15 mm silk-covered copper wire.

L_s = 9 turns Ø 0.15 mm.

L_1 = 31 μH (150 turns ∅ 0.04 mm wound on 1/2 W - 5.6 kΩ resistor).
L_2 = 18 μH; Q_o = 75; (double-layer winding, 45 turns ∅ 0.08 with powdered-iron core).

Fig. 3 - Test setup for measurement of total device dissipation, quiescent current into pin 11 and drain current from 6.2 Volt

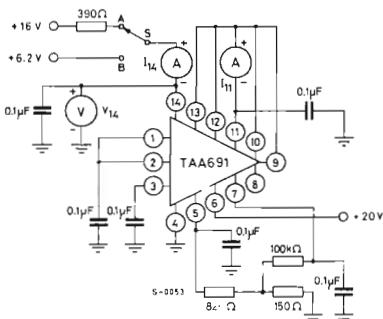



Fig. 4 - Test setup for measurement of input-impedance

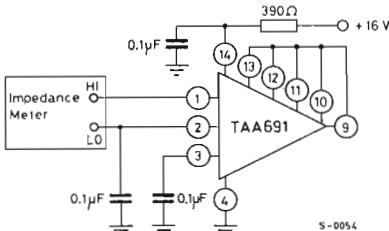



Fig. 5 - Test setup for measurement of AM rejection, input limiting voltage, FM-detector output voltage and distortion

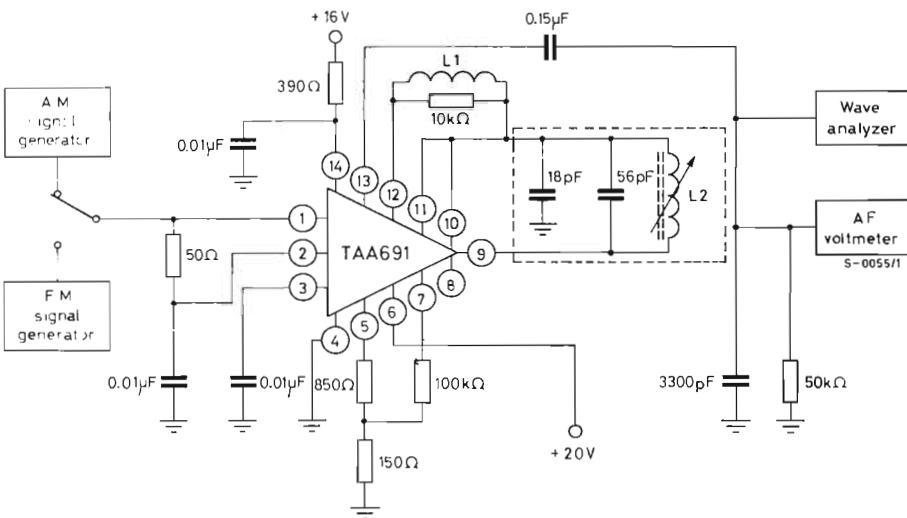



Fig. 6 - Typical FM-detector output voltage versus input voltage

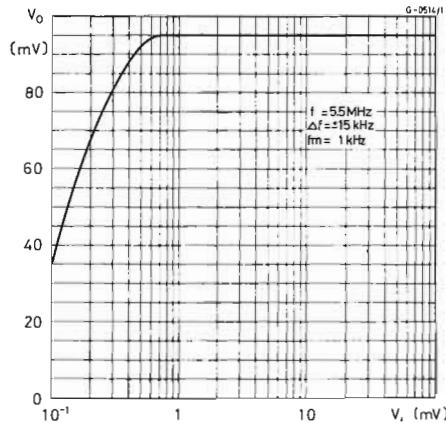



Fig. 7 - Typical amplitude-modulation rejection versus input voltage

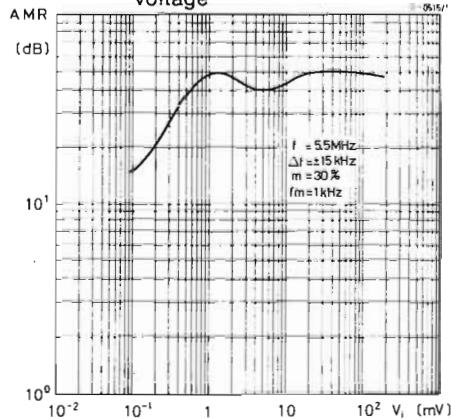



Fig. 8 - Test setup for measurement of IF amplifier voltage gain

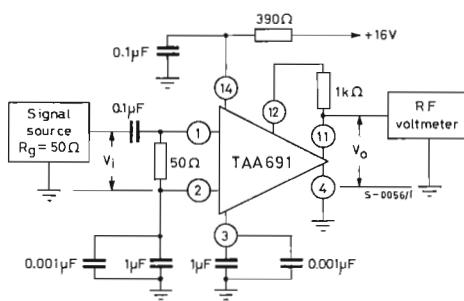



Fig. 9 - Typical IF amplifier voltage gain and input limiting voltage characteristics

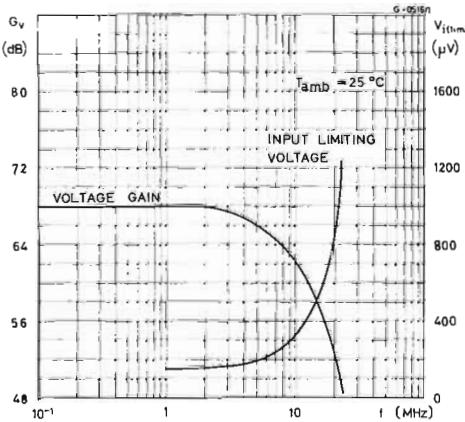
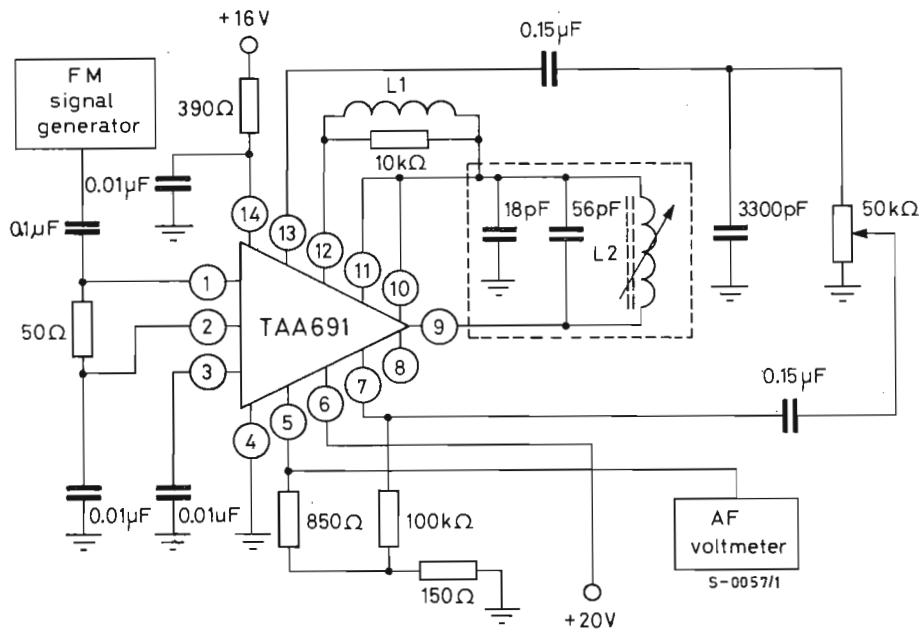



Fig. 10 - Test setup for measurement of audio output voltage

LINEAR INTEGRATED CIRCUIT

TBA 231

DUAL LOW NOISE OPERATIONAL AMPLIFIER

- SINGLE or DUAL SUPPLY OPERATION
- LOW NOISE FIGURE
- HIGH GAIN
- LARGE INPUT VOLTAGE RANGE
- EXCELLENT GAIN STABILITY VERSUS SUPPLY VOLTAGE
- NO LATCH UP
- OUTPUT SHORT CIRCUIT PROTECTED

The TBA 231 is a monolithic integrated dual operational amplifier in a 14-lead dual in-line plastic package.
These low-noise, high-gain amplifiers show extremely stable operating characteristics over a wide range of supply voltage and temperatures.
The device is intended for a variety of applications requiring two high performance operational amplifiers, such as phono and tape stereo preamplifier, TV remote control receiver, etc.

ABSOLUTE MAXIMUM RATINGS

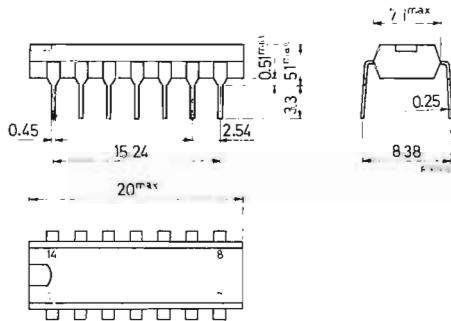
V_s	Supply voltage	± 18	V
	Differential input voltage	± 5	V
	Common mode input voltage	± 15	V
P_{tot}	Power dissipation at $T_{amb} \leq 60\ °C$	500	mW
T_{stg}	Storage temperature	-55 to 125	°C
T_{op}	Operating temperature	0 to 70	°C

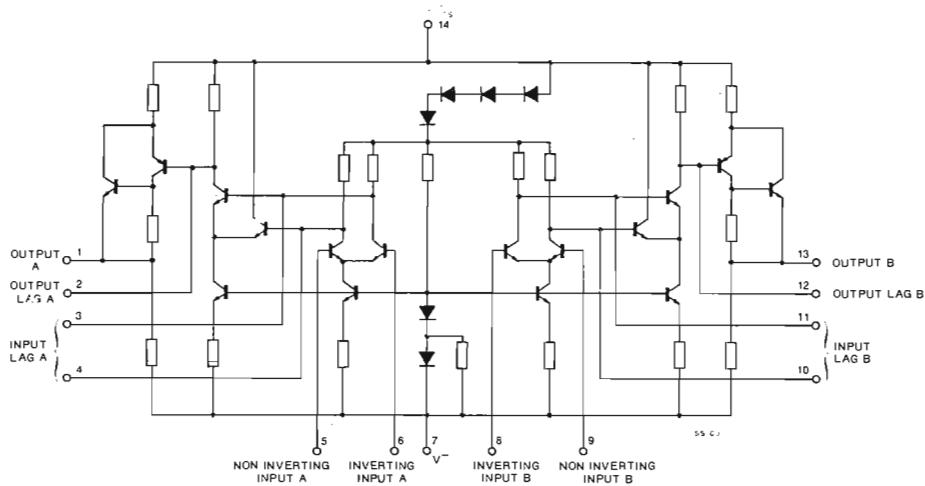
* For $V_s \leq \pm 15$ V, V_i max = V_s

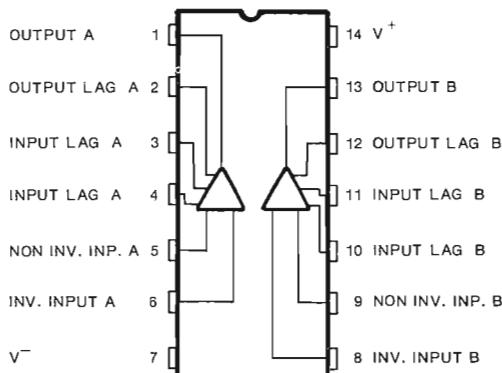
ORDERING NUMBER: TBA 231

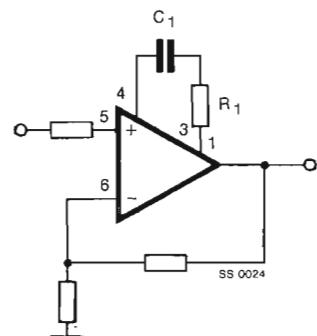
MECHANICAL DATA

Dimensions in mm

5/73

TBA 231

SCHEMATIC DIAGRAM

CONNECTION DIAGRAM

(top view)

TEST CIRCUIT

Frequency response

ELECTRICAL CHARACTERISTICS

(T_{amb} = 25 °C, R_L = 50 kΩ to pin 7 unless otherwise specified)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_s = ± 15 V						
I_d	Quiescent drain current	$V_o = 0$		9	14	mA
$\lvert V_{BE1}-V_{BE2}\rvert$	Input offset voltage	R_s = 200 Ω		1	6	mV
$\lvert I_{B1}-I_{B2}\rvert$	Input offset current			50	1000	nA
I_b	Input bias current			250	2000	nA
	Common mode input voltage range		±10	±11		V
R_i	Input resistance	f = 1 kHz	37	150		kΩ
G_V	Voltage gain	V_o = ±5 V	6500	20.000		—
V_o	Positive output voltage swing		+12	+13		V
V_o	Negative output voltage swing		-14	-15		V
R_o	Output resistance	f = 1 kHz		5		kΩ
CMRR	Common mode rejection ratio	R_s = 200 Ω	70	90		dB
SVR	Supply voltage rejection	R_s = 200 Ω		50		μV/V
SR	Slew rate	Unity gain C_1 = 0.1 μF R_1 = 4.7 Ω see frequency response test circuit		1		V/μs
	Channel separation	R_s = 10 kΩ f = 10 kHz		140		dB
NF	Noise figure	R_s = 10 kΩ B = 10 Hz to 10 kHz		1.5		dB
V_s = ± 4 V						
I_d	Quiescent drain current	$V_o = 0$		2.5		mA
$\lvert V_{BE1}-V_{BE2}\rvert$	Input offset voltage	R_s = 200 Ω		1	6	mV

ELECTRICAL CHARACTERISTICS (continued)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$\lvert I_{B1}-I_{B2} \rvert$	Input offset current			50	1000	nA
I_b	Input bias current			250		nA
G_V	Voltage gain	$V_o = \pm 1$ V	2500	15.000		—
V_o	Positive output voltage swing		+2.5	+2.8		V
V_o	Negative output voltage swing		-3.6	-4		V

Fig. 1 - Power rating chart

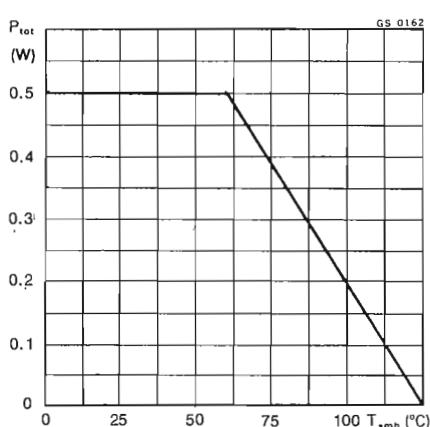



Fig. 2 - Typical output capability vs supply voltage

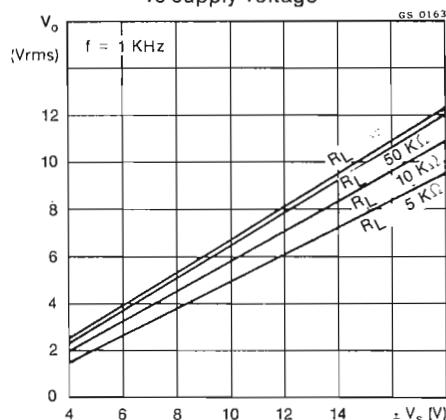



Fig. 3 - Typical quiescent drain current vs supply voltage

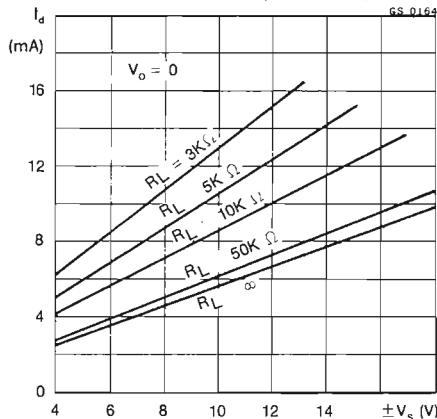



Fig. 4 - Typical open loop voltage gain vs supply voltage

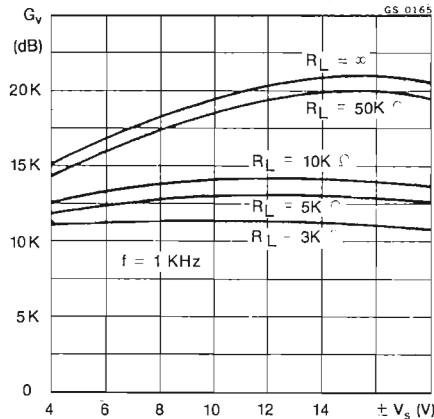



Fig. 5 - Typical open loop frequency response using recommended compensation networks

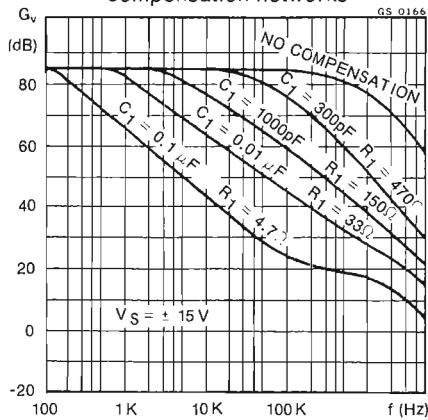



Fig. 6 - Output voltage swing vs frequency for various compensation networks

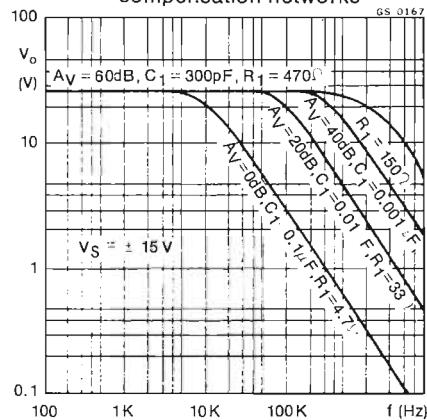



Fig. 7 - Typical input noise voltage vs frequency

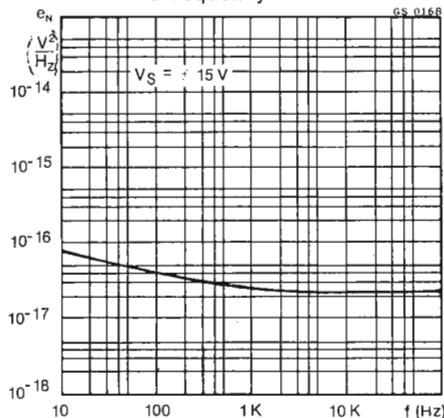



Fig. 8 - Typical input noise current vs frequency

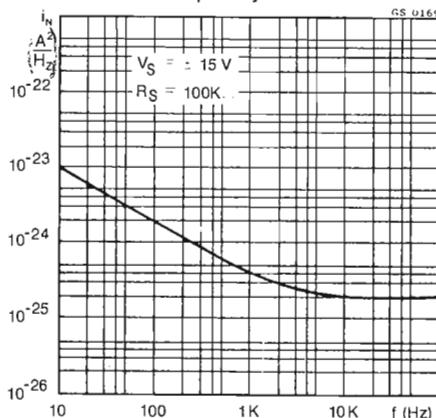



Fig. 9 - Typical closed loop gain vs frequency

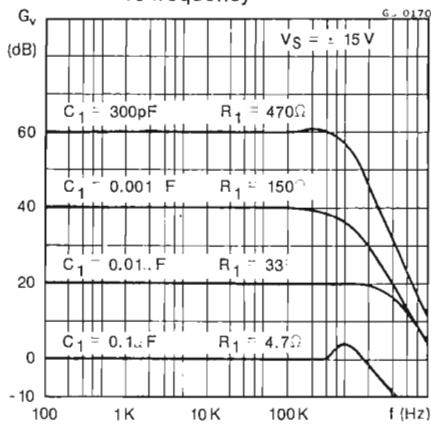
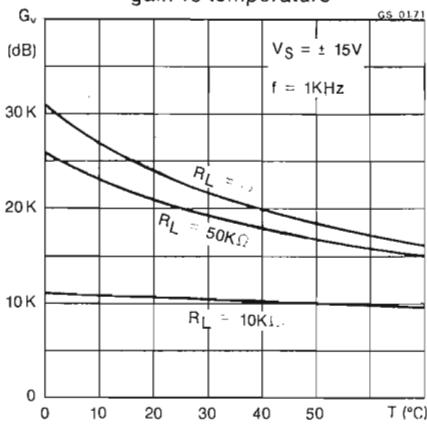



Fig. 10 - Typical open loop voltage gain vs temperature

TBA 261

LINEAR INTEGRATED CIRCUIT

FM IF AMPLIFIER-LIMITER, DETECTOR, DC VOLUME CONTROL

- AUDIO OUTPUT VOLTAGE 0.9 V_{rms}
- REMOTE CONTROL RANGE 70 dB
- INPUT LIMITING VOLTAGE 100 µV

The TBA 261 is a monolithic integrated circuit in a 14-lead quad in-line or dual in-line plastic package. It is particularly designed for use in TV sound IF or FM IF amplifiers; it includes: a three stages FM limiter amplifier, a gated coincidence detector and a remote control stage.

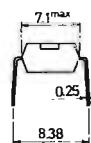
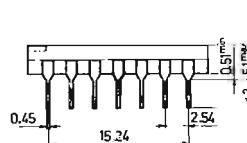
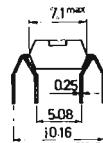
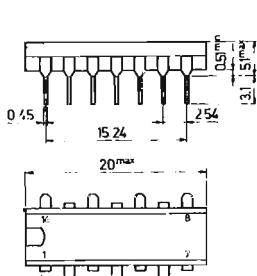
ABSOLUTE MAXIMUM RATINGS

V_s	Supply voltage	15	V
P_{tot}	Power dissipation at $T_{amb} \leq 70\ °C$	500	mW
T_{stg}	Storage temperature	-55 to 125	°C
T_{op}	Operating temperature	0 to 70	°C

ORDERING NUMBERS:

TBA 261 AX2 (for 14-lead quad in-line plastic package)
TBA 261 AX7 (for 14-lead dual in-line plastic package)

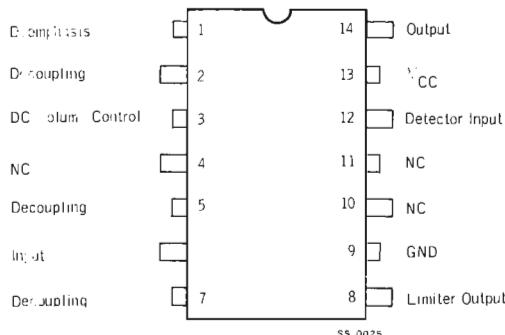
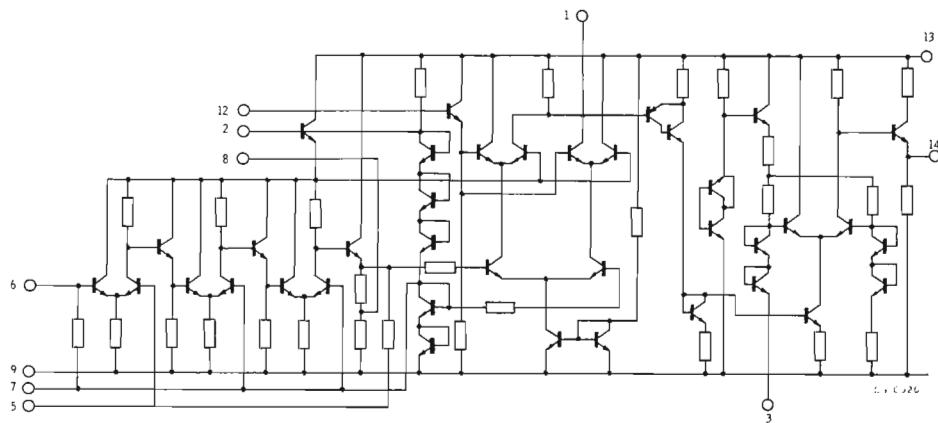
MECHANICAL DATA

Dimensions in mm

TBA 261 AX2

TBA 261 AX7

TBA 261

CONNECTION DIAGRAM

(top view)

SCHEMATIC DIAGRAM

ELECTRICAL CHARACTERISTICS

(T_{amb} = 25 °C, V_s = 12 V unless otherwise noted)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_d	Quiescent drain current	$V_3 = 0$		20		mA
$V_{i(threshold)}$	Input limiting voltage	$R_s = 50\ \Omega$ f = 5.5 MHz $\Delta f = \pm 25$ kHz		100		μV
V_o	Recovered output voltage	V_i = 10 mV $R_s = 50\ \Omega$ f = 5.5 MHz f_m = 1 kHz $\Delta f = \pm 25$ kHz		0.9		V_{rms}
	Remote control range			70		dB
AMR	Amplitude modulation rejection	V_i = 10 mV $R_s = 50\ \Omega$ f = 5.5 MHz m = 0.3 $\Delta f = \pm 50$ kHz $\Delta f = \pm 25$ kHz		50 45		dB dB
d	Distortion	V_i = 10 mV $R_s = 50\ \Omega$ f = 5.5 MHz f_m = 1 kHz $\Delta f = \pm 25$ kHz		1		%
R_i	Input resistance	V_i = 10 mV f = 5.5 MHz		5		kΩ
C_i	Input capacitance	V_i = 10 mV f = 5.5 MHz		3		pF

Fig. 1 - Typical relative audio output voltage vs input voltage

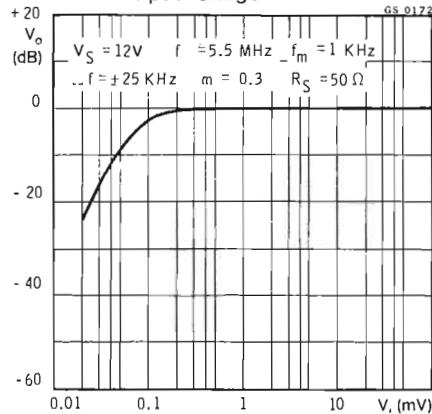



Fig. 2 - Typical relative audio output voltage vs volume control resistance

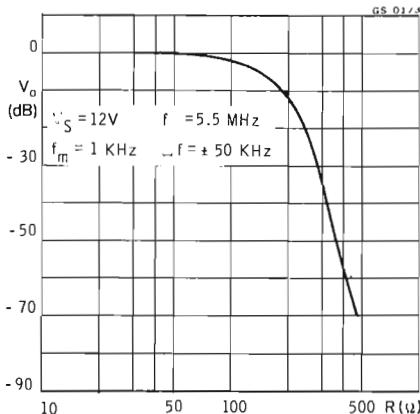



Fig. 3 - Maximum output voltage swing vs load resistance

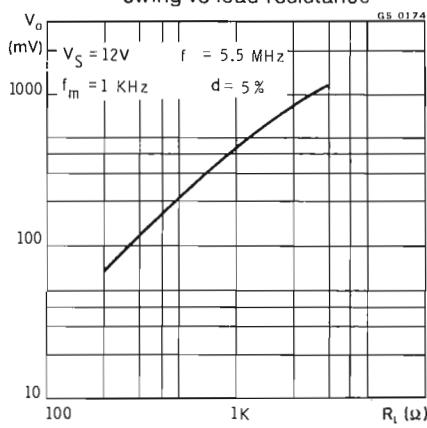



Fig. 4 - Typical audio output voltage vs frequency variation

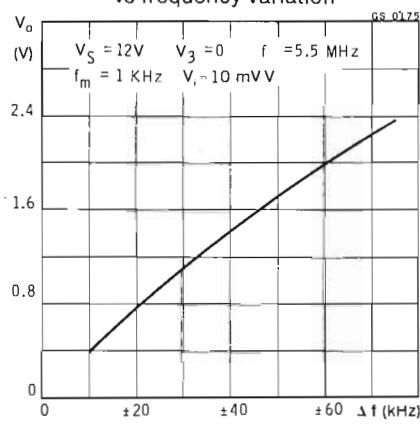



Fig. 5 - Typical relative audio output voltage vs modulating frequency

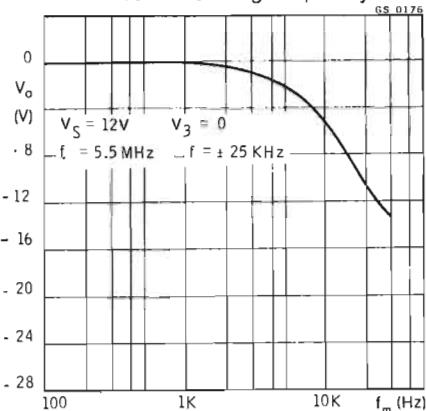



Fig. 6 - Typical distortion vs modulating frequency

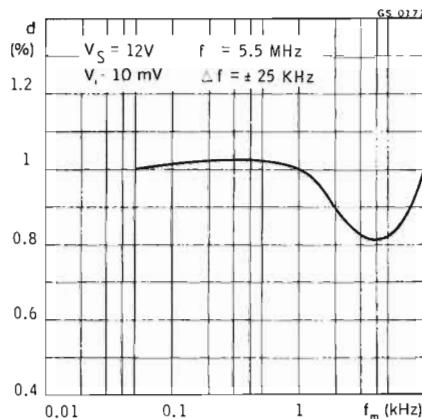



Fig. 7 - Typical distortion vs frequency deviation

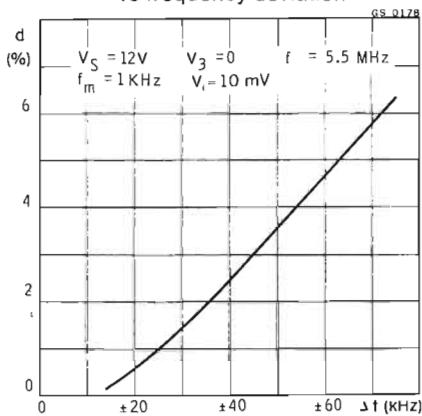
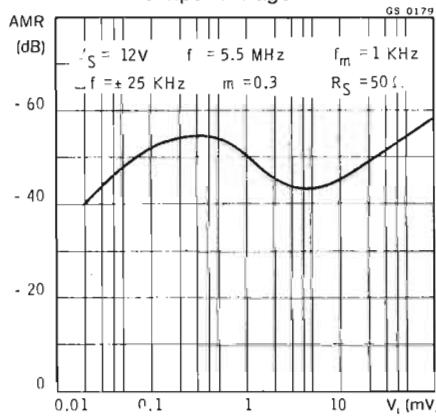
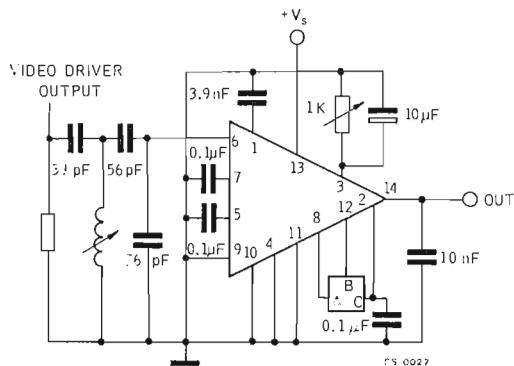
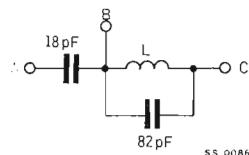



Fig. 8 - Typical AM rejection vs input voltage

TBA 261

TYPICAL APPLICATION

TV sound IF amplifier (5.5 MHz)

Frequency shift network

$L = 55$ t $\varnothing = 0.2$ mm.

$Q_o = 86$ at 5.5 MHz with tuning capacitor and without shield.

$Q_o = 57$ at 5.5 MHz with tuning capacitor and with shield connected to ground.

LINEAR INTEGRATED CIRCUIT

TBA 311

TV SIGNAL PROCESSING CIRCUIT

The TBA 311 is a monolithic integrated circuit in a 16-lead dual in-line or quad in-line plastic package. It is intended for use as signal processing circuit for black and white and colour television sets.
The circuit is designed for receivers equipped with tubes or transistors in the deflection and video output stages, and with PNP or NPN transistors in the tuner and NPN in the IF amplifier.
Only signals with the negative modulation can be handled by the circuit. The circuit is protected against short circuit between video output and GND. The TBA 311 includes:

- VIDEO PREAMPLIFIER with EMITTER FOLLOWER OUTPUT
- GATED AGC for VIDEO IF AMPLIFIER and TUNER
- NOISE INVERTER CIRCUIT for GATING AGC and SYNC. PULSE SEPARATOR
- HORIZONTAL SYNC. PULSE SEPARATOR
- VERTICAL SYNC. PULSE SEPARATOR
- BLANKING FACILITY for the VIDEO AMPLIFIER

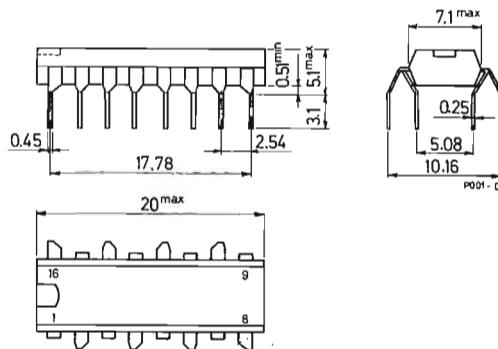
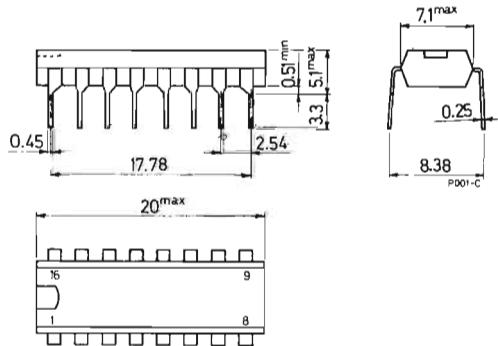
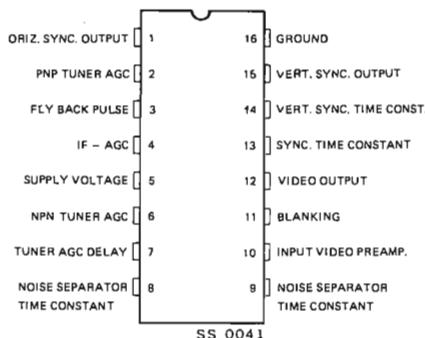
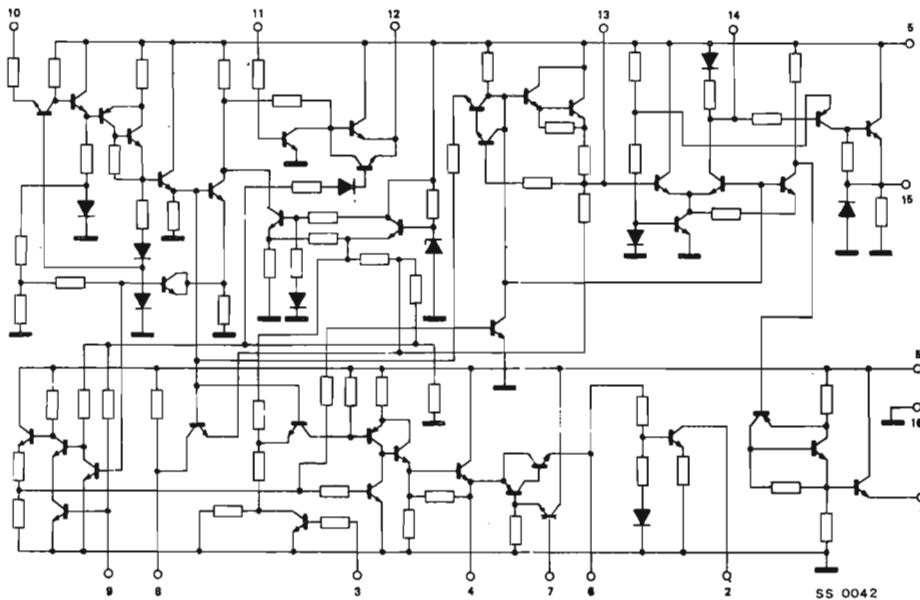
ABSOLUTE MAXIMUM RATINGS

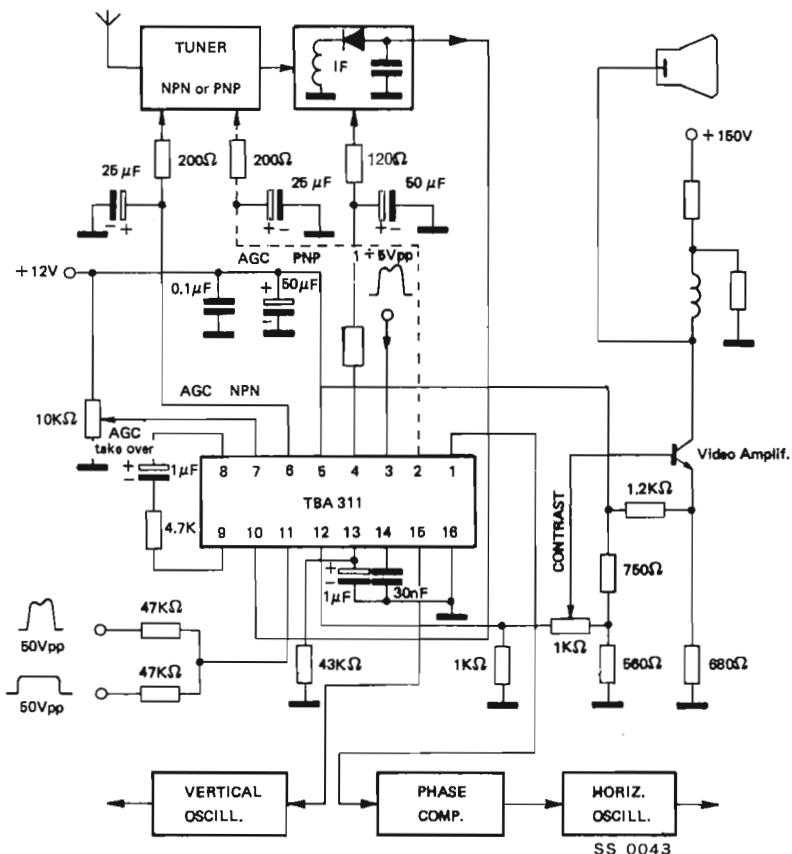
V_s	Supply voltage	16	V
P_{tot}	Power dissipation at $T_{amb} \leq 70\ °C$	500	mW
T_{stg}	Storage temperature	-55 to 125	°C
T_{op}	Operating temperature	-25 to 70	°C

ORDERING NUMBERS:

TBA 311 A22 (for 16-lead quad in-line plastic package)
TBA 311 A17 (for 16-lead dual in-line plastic package)

MECHANICAL DATA (Dimensions in mm)

Quad in-line plastic package
for TBA 311 A22

Dual in-line plastic package
for TBA 311 A17

CONNECTION DIAGRAM
(top view)

SCHEMATIC DIAGRAM

TEST CIRCUIT

ELECTRICAL CHARACTERISTICS

(T_{amb} = 25 °C, V_s = 12 V unless otherwise specified, see also test circuit)

	Parameter		Min.	Typ.	Max.	Unit
I_d	Quiescent drain current			14		mA

VIDEO AMPLIFIER

	Parameter		Min.	Typ.	Max.	Unit
R_i	Input resistance (pin 10)			2.7		kΩ
C_i	Input capacitance (pin 10)			0.8		pF
B	Bandwidth (-3 dB)		5			MHz
G_v	Voltage gain			9.5		dB
V_i	Peak to peak video input voltage (pin 10)	(1)		2		V
V_o	Peak to peak video output voltage (pin 12)	(2)		6		V
V	Black level at the output (pin 12)	(3)		5		V
I_o	Available video peak output current	(4)		20		mA
$\frac{\Delta V_o}{\Delta T_{amb}}$	Video output voltage temperature drift	(5)		1		mV/°C
$\frac{\Delta V}{\Delta T_{amb}}$	Black level temperature drift			0.2		mV/°C
$\frac{\Delta V}{\Delta V_s}$	Black level drift at the output with supply voltage variation			0.5		V/V

VIDEO BLANKING

	Parameter	Min.	Typ.	Max.	Unit
V_i	Peak to peak input voltage (pin 11)	1		5	V
R_i	Input resistance (pin 11)		1		kΩ

AGC CIRCUIT

	Parameter	Value	Unit
V	Control voltage IF amplifier (pin 4)	0 to 7.5	V
V	Control voltage tuner NPN (pin 6) PNP (pin 2)	0 to 6.5 12 to 6	V V

ELECTRICAL CHARACTERISTICS (continued)

	Parameter		Min.	Typ.	Max.	Unit
$\frac{\Delta V_i}{\Delta V}$	Signal expansion for full control of IF amplifier and tuner			10		%
V	Peak to peak keying input pulse (pin 3)	(6)	1		5	V
R_i	Input resistance (pin 3)			2		kΩ

SYNC. CIRCUITS

	Parameter	Min.	Typ.	Max.	Unit
V_o	Output voltage of horizontal sync. pulse (pin 1)	8.4	10		V
Z_o	Horizontal output impedance (pin 1)		100		Ω
V_o	Output voltage of vertical sync. pulse (pin 15)	8.4	9.5		V
Z_o	Vertical output impedance (pin 15)		2		kΩ

NOTES:

1) Negative going video signal (no pre-bias needed for the detector).
2) Video signal with negative going sync. pulse.
3) Only valid if the video signal is in accordance with the CCIR standard.
4) The total load on pin 12 must be such that under nominal conditions $I_o \leq 20$ mA.
5) Because the integrated circuit reaches 95% of its final working temperature in 100 seconds, the temperature variations to be considered are those caused by the slower rise in cabinet temperature and by changes in room temperature.
6) The TBA 311 may be operated unkeyed but then point 3 must be connected to the positive supply line via a resistor of suitable value (e.g. 10 kΩ). However, the following consequences should be borne in mind:
   — The decoupling capacitors at the IF and tuner control points must be larger to prevent ripple voltages due to the vertical sync pulses. In consequence the AGC will not follow fast signal fluctuations (aircraft flutter).

TBA 331

LINEAR INTEGRATED CIRCUIT

GENERAL PURPOSE

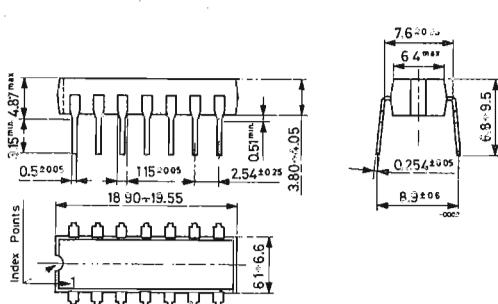
The TBA 331 is an assembly of 5 silicon NPN transistors on a common monolithic substrate in a Jedec TO-116 14-lead dual in-line plastic package. Two transistors are internally connected to form a differential amplifier.
The transistors of the TBA 331 are well suited to low noise general purposes and to a wide variety of applications in low power systems in the DC through VHF range. They may be used as discrete components in conventional circuits, in addition, they provide the very significant inherent integrated circuit advantages of close electrical and thermal matching.

ABSOLUTE MAXIMUM RATINGS

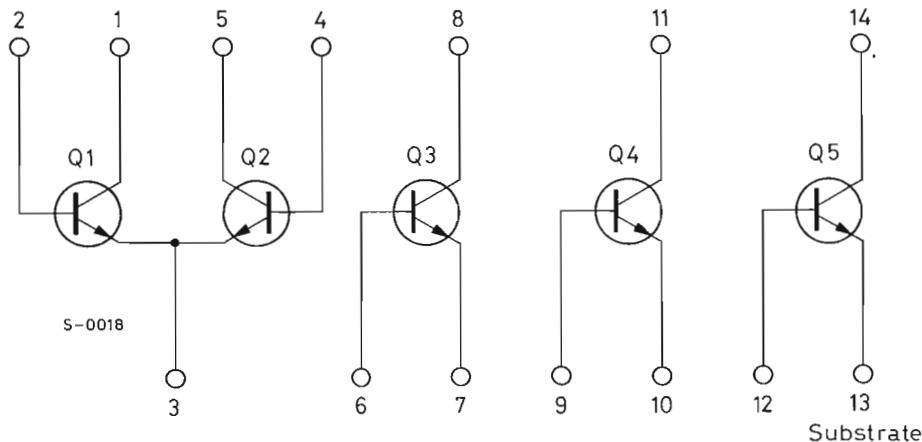
		Each transistor	Total package	
V_{CBO}	Collector-base voltage ($I_E = 0$)	20	—	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	15	—	V
V_{CSS}*	Collector-substrate voltage	20	—	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	5	—	V
I_C	Collector current	50	—	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 55\,°C$	300	750	mW
	at $T_{amb} > 55\,°C$	Derate at 6.67 mW/°C		
T_{stg}	Storage temperature	-25 to 85		°C
T_{op}	Operating temperature	0 to 85		°C

* The collector of each transistor of the TBA 331 is isolated from the substrate by an integrated diode. The substrate (pin 13) must be connected to the most negative point in the external circuit to maintain isolation between transistors and to provide for normal transistor action.

MECHANICAL DATA

Dimensions in mm

TO-116

TBA 331

SCHEMATIC DIAGRAM

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit	Fig.
I_{CBO}	Collector cutoff current ($I_E = 0$)	$V_{CB} = 10$ V		0.002	40	nA	1
I_{CEO}	Collector cutoff current ($I_B = 0$)	$V_{CE} = 10$ V		see curve	0.5	µA	2
$\lvert I_{B1} - I_{B2} \rvert$	Input offset current	$I_C = 1$ mA $V_{CE} = 3$ V		0.3	2	µA	7

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit	Fig.
V_{CBO}	Collector-base voltage ($I_E = 0$)	$I_C = 10\ \mu A$	20	60		V	—
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	$I_C = 1\ mA$	15	24		V	—
V_{CSS}	Collector-substrate voltage ($I_{CSS} = 0$)	$I_C = 10\ \mu A$	20	60		V	—
$V_{CE\ (sat)}$	Collector-emitter saturation voltage	$I_B = 1\ mA$ $I_C = 10\ mA$		0.23		V	—
V_{EBO}	Emitter-base voltage ($I_C = 0$)	$I_E = 10\ \mu A$	5	7		V	—
V_{BE}	Base-emitter voltage	$I_E = 1\ mA$ $V_{CE} = 3\ V$ $I_E = 10\ mA$ $V_{CE} = 3\ V$		0.715 0.8		V V	4 4
$\|V_{BE1}-V_{BE2}\|$	Input offset voltage	$I_C = 1\ mA$ $V_{CE} = 3\ V$		0.45	5	mV	4-6
$\|V_{BE3}-V_{BE4}\|$	Input offset voltage	$I_C = 1\ mA$ $V_{CE} = 3\ V$		0.45	5	mV	4-6
$\|V_{BE4}-V_{BE5}\|$	Input offset voltage	$I_C = 1\ mA$ $V_{CE} = 3\ V$		0.45	5	mV	4-6
$\|V_{BE5}-V_{BE4}\|$	Input offset voltage	$I_C = 1\ mA$ $V_{CE} = 3\ V$		0.45	5	mV	4-6
$\frac{\Delta V_{BE}}{\Delta T}$	Base-emitter voltage temperature coefficient	$I_C = 1\ mA$ $V_{CE} = 3\ V$		-1.9		mV/°C	5
$\frac{\|V_{BE1}-V_{BE2}\|}{\Delta T}$	Input offset voltage temperature coefficient	$I_C = 1\ mA$ $V_{CE} = 3\ V$		1.1		µV/°C	6

ELECTRICAL CHARACTERISTICS (continued)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit	Fig.
h_{FE}	DC current gain	I_C = 10 mA V_{CE} = 3 V		100		—	3
		I_C = 1 mA V_{CE} = 3 V	40	100		—	3
		I_C = 10 μA V_{CE} = 3 V		54		—	3
f_T	Transition frequency	I_C = 3 mA V_{CE} = 3 V	300	550		MHz	14
NF	Noise figure	I_C = 100 μA V_{CE} = 3 V f = 1 kHz R_g = 1 kΩ		3.25		dB	8
h_{ie}	Input impedance	I_C = 1 mA V_{CE} = 3 V f = 1 kHz		3.5		kΩ	9
h_{fe}	Forward current transfer ratio	I_C = 1 mA V_{CE} = 3 V f = 1 kHz		110		—	9
h_{re}	Reverse voltage transfer ratio	I_C = 1 mA V_{CE} = 3 V f = 1 kHz		1.8×10^{-4}		—	9
h_{oe}	Output admittance	I_C = 1 mA V_{CE} = 3 V f = 1 kHz		15.6		μS	9
y_{ie}	Input admittance	I_C = 1 mA V_{CE} = 3 V f = 1 MHz		0.3+j0.04		mS	11
y_{fe}	Forward transadmittance	I_C = 1 mA V_{CE} = 3 V f = 1 MHz		31-j1.5		mS	10
y_{re}	Reverse transadmittance	I_C = 1 mA V_{CE} = 3 V f = 1 MHz		see curve		mS	13

ELECTRICAL CHARACTERISTICS (continued)

	Parameter	Test Conditions	Min. Typ. Max.	Unit	Fig.
y_{oe}	Output admittance	$I_C = 1$ mA $V_{CE} = 3$ V f = 1 MHz	0.001 + j0.03	mS	12
C_{EBO}	Emitter-base capacitance	$I_C = 0$ $V_{EB} = 3$ V	0.6	pF	—
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = 3$ V	0.58	pF	—
C_{CSS}	Collector-sustrate capacitance	$I_C = 0$ $V_{CSS} = 3$ V	2.8	pF	—

Fig. 1 - Typical collector cutoff current

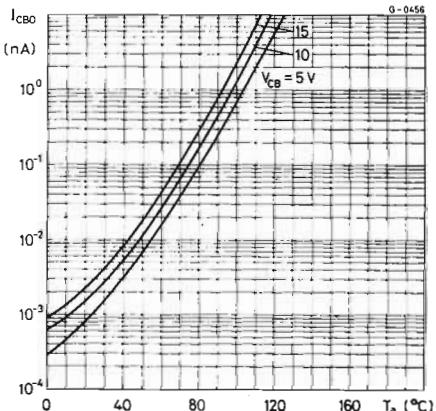



Fig. 2 - Typical collector cutoff current

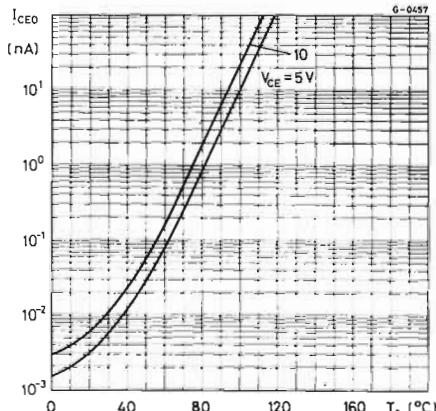



Fig. 3 - Typical DC current gain

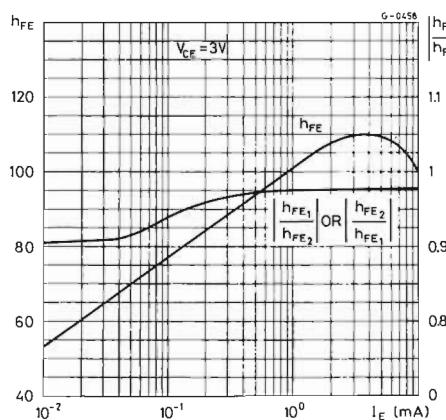



Fig. 4 - Typical input voltage and input voltage offset

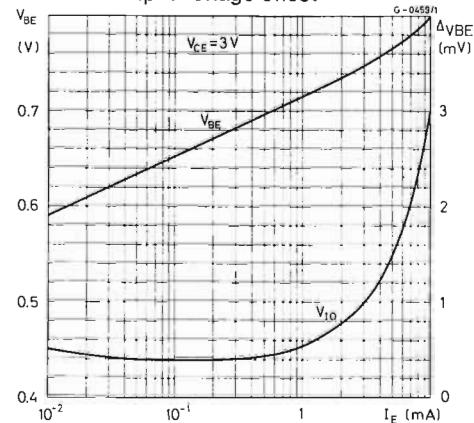



Fig. 5 - Typical input characteristic for each transistor

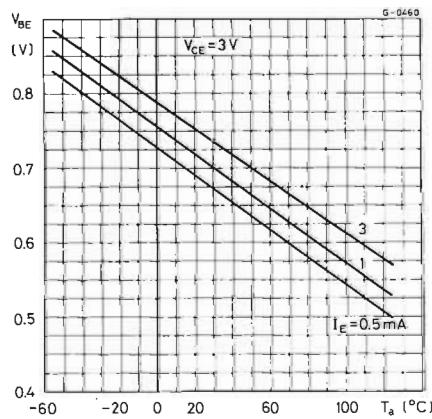



Fig. 6 - Typical input voltage offset

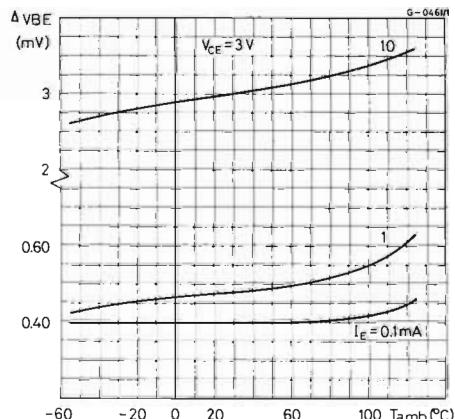



Fig. 7 - Typical input current offset for matched transistor pair

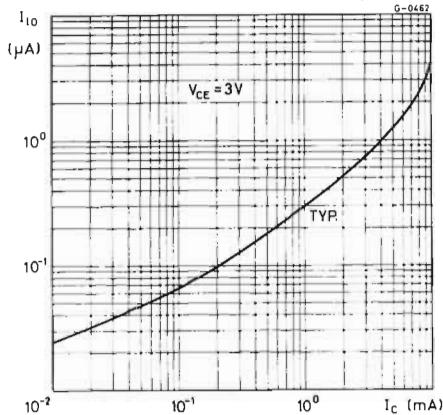



Fig. 8 - Typical noise figure

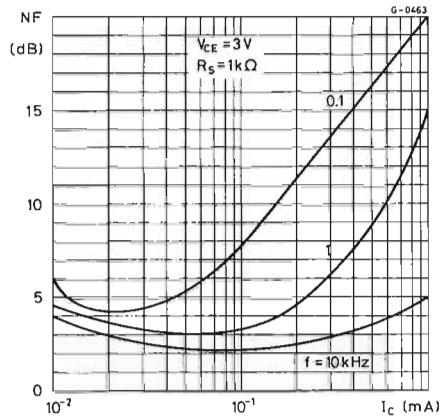



Fig. 9 - Typical normalized h parameters

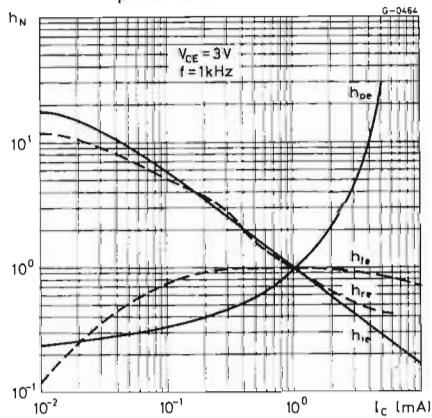



Fig. 10 - Typical forward admittance

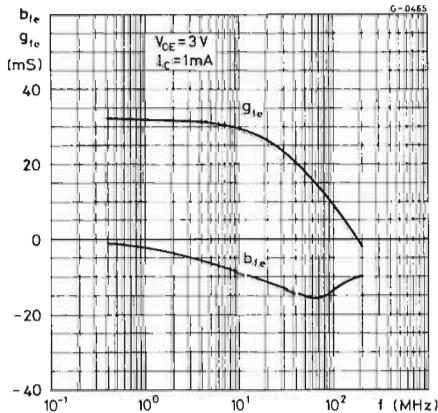



Fig. 11 - Typical input admittance

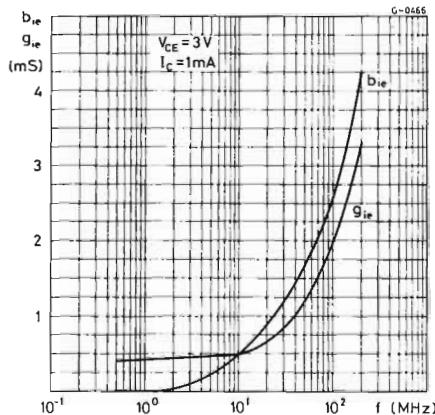



Fig. 12 - Typical output admittance

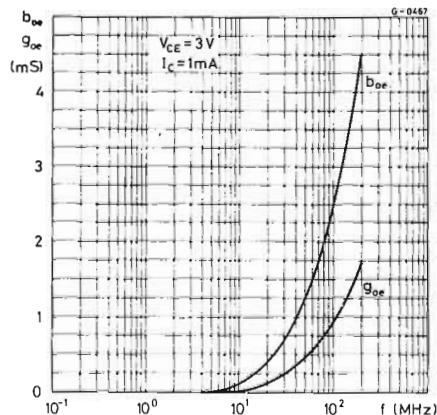



Fig. 13 - Typical reverse admittance

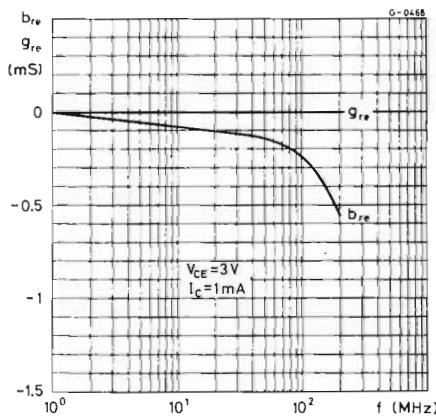
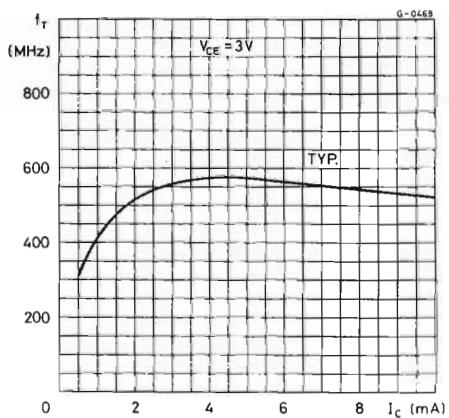



Fig. 14 - Transition frequency

TBA 435

LINEAR INTEGRATED CIRCUIT

VOLTAGE REGULATOR

- OUTPUT CURRENT ≥ 100 mA
- TIGHT TOLERANCE for OUTPUT VOLTAGE
- LOAD REGULATION ≤ 1%
- RIPPLE REJECTION 57 dB TYPICAL
- OVERLOAD and SHORT CIRCUIT PROTECTION

The TBA 435 is an integrated monolithic 8.5 V voltage regulator in TO-39 metal case which can supply more than 100 mA. The device features high temperature stability, internal overload and short circuit protection, low output impedance and excellent transient response. The TBA 435 is intended for use as voltage supply for consumer circuits and for any other industrial application.

ABSOLUTE MAXIMUM RATINGS

V_i	Input voltage	20	V
P_{tot}	Power dissipation at $T_{amb} = 25\ °C$	0.75	W
	at $T_{case} = 25\ °C$	4	W
T_{stg}	Storage temperature	-55 to 150	°C
T_j	Junction temperature	175	°C
T_{op}	Operating temperature	0 to 70	°C

ORDERING NUMBER: TBA 435A X5

MECHANICAL DATA

Dimensions in mm

Ground connected to case

TBA 435

SCHEMATIC DIAGRAM

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	37.5	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	200	°C/W

ELECTRICAL CHARACTERISTICS (T_j = 25 °C unless otherwise specified)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_o	Output voltage	V_i = 11.5 V to 20 V I_o = 5 mA C_L = 10 μF	8.1	8.5	8.9	V
$\frac{\Delta V_o}{V_o}$	Load regulation	V_i = 11.5 V to 20 V I_o = 5 mA to 100 mA C_L = 10 μF		0.3	1	%
I_o	Regulated current	V_i = 15 V $\frac{\Delta V_o}{V_o} \leq 1\%$	100	140		mA

ELECTRICAL CHARACTERISTICS (continued)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_o	Max. regulated current	V_i = 15 V	130	150	200	mA
R_o	Output resistance	V_i = 15 V I_o = 5 mA to 100 mA		0.1		Ω
$\frac{\Delta V_o}{V_o}$	Line regulation	V_i = 11.5 V to 20 V I_o = 5 mA		0.15	0.6	%
SVR	Supply voltage rejection	V_i = 13.5 V ΔV_i = 4 V_{pp} I_o = 5 mA C_L = 10 μF f = 100 Hz	46	57		dB
e_N	Output noise voltage	V_i = 15 V I_o = 5 mA C_L = 10 μF B = 100 Hz to 100 kHz		100		μV
I_d	Quiescent drain current	V_i = 20 V I_o = 0	5	9	16	mA
$\frac{\Delta V_o}{\Delta T_{amb}}$	Temperature coefficient	V_i = 15 V I_o = 5 mA C_L = 10 μF T_{amb} = 0 to 70 °C		0.85		mV/°C
I_{sc}	Output short circuit current	V_i = 20 V V_o = 0		40	60	mA

Fig. 1 - Typical output voltage vs output current

Fig. 2 - Power rating chart

Fig. 3 - Maximum output current vs junction temperature

Fig. 4 - Typical ripple rejection vs regulated output current

Fig. 5 - Typical ripple rejection vs frequency

Fig. 6 - Maximum output current vs input voltage

Fig. 7 - Typical short circuit output current vs input voltage

Fig. 8 - Typical short circuit output current vs junction temperature

Fig. 9 - Typical dropout voltage vs output current

Fig. 10 - Typical quiescent drain current vs junction temperature

Fig. 11 - Typical quiescent drain current vs input voltage

Fig. 12 - Typical output resistance vs frequency

Line transient response
(I_o = 5 mA)

Turn on time
(I_o = 100 mA)

TYPICAL APPLICATIONS

Fig. 13 - Positive output voltage regulator

Fig. 14 - Negative output voltage regulator

Fig. 15 - Adjustable output voltage regulator

$V_o = V_1 (1 + \frac{R_2}{R_1}) + I_G R_2$

V_i = 18 V

V_o = 8.5 to 11 V

I_o > 80 mA

R_o = 100 mΩ

R_2 potentiometer 0 to 150 Ω

Typical adjustable output voltage vs output current

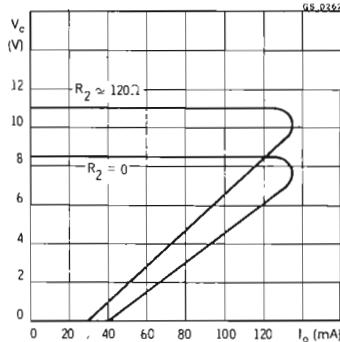
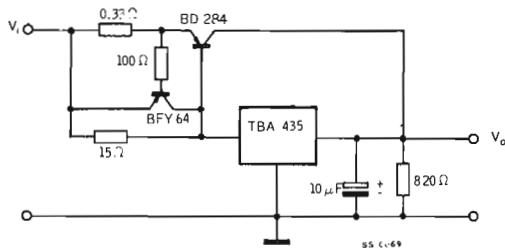
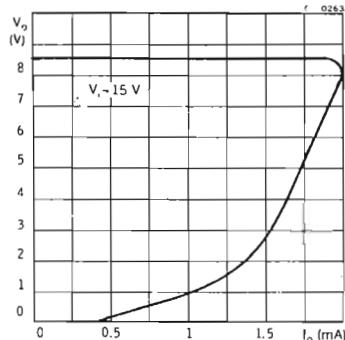



Fig. 16 - PNP current boost circuit

V_i = 15 V

V_o 8.5 V

I_o = 2 A

R_o ≤ 20 mΩ

Typical output voltage vs output current

TBA 625A

LINEAR INTEGRATED CIRCUIT

VOLTAGE REGULATOR

- OUTPUT CURRENT $\geq$ 100 mA
- TIGHT TOLERANCE for OUTPUT VOLTAGE
- LOAD REGULATION $\leq$ 1%
- RIPPLE REJECTION 60 dB TYPICAL
- OVERLOAD and SHORT CIRCUIT PROTECTION

The TBA 625A is an integrated monolithic 5 V voltage regulator in TO-39 metal case which can supply more than 100 mA. The device features high temperature stability, internal overload and short circuit protection, low output impedance and excellent transient response. The TBA 625A is intended for use as voltage supply for digital circuits and for any other industrial application.

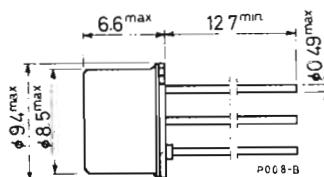
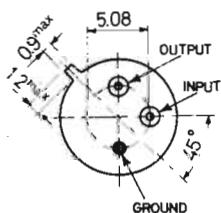
ABSOLUTE MAXIMUM RATINGS

V_i	Input voltage	20	V
P_{tot}	Power dissipation at $T_{amb} = 25\,°C$	0.75	W
	at $T_{case} = 25\,°C$	4	W
T_{stg}	Storage temperature	-55 to 150	°C
T_j	Junction temperature	175	°C
T_{op}	Operating temperature	0 to 70	°C

ORDERING NUMBER: TBA 625A X5

MECHANICAL DATA

Dimensions in mm

Ground connected to case

TBA 625A

SCHEMATIC DIAGRAM

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	37.5	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	200	°C/W

ELECTRICAL CHARACTERISTICS (T_j = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
V_o	Output voltage	V_i = 8 V to 20 V I_o = 5 mA C_L = 10 μF	4.75	5	5.25	V
$\frac{\Delta V_o}{V_o}$	Load regulation	V_i = 8 V to 20 V I_o = 5 mA to 100 mA C_L = 10 μ		0.3	1	%
I_o	Regulated current	V_i = 12 V $\frac{\Delta V_o}{V_o} \leq 1\%$	100	140		mA

ELECTRICAL CHARACTERISTICS (continued)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_o	Max. regulated current	V_i = 12 V	130	150	200	mA
R_o	Output resistance	V_i = 12 V I_o = 5 mA to 100 mA		0.1		Ω
$\frac{\Delta V_o}{V_o}$	Line regulation	V_i = 8 V to 20 V I_o = 5 mA C_L = 10 μF		0.2	1	%
SVR	Supply voltage rejection	V_i = 10 V ΔV_i = 4 V_{pp} I_o = 5 mA C_L = 10 μF f = 100 Hz	46	60		dB
e_N	Output noise voltage	V_i = 12 V I_o = 5 mA C_L = 10 μF B = 10 Hz to 100 kHz		70		μV
I_d	Quiescent drain current	V_i = 20 V I_o = 0	5	9	16	mA
$\frac{\Delta V_o}{\Delta T_{amb}}$	Temperature coefficient	V_i = 12 V I_o = 5 mA C_L = 10 μF T_{amb} = 0 to 70 °C		0.5		mV/°C
I_{sc}	Output short circuit current	V_i = 20 V V_o = 0		45	65	mA

Fig. 1 - Typical output voltage vs output current

Fig. 2 - Power rating chart

Fig. 3 - Maximum output current vs junction temperature

Fig. 4 - Typical ripple rejection vs regulated output current

Fig. 5 - Typical ripple rejection vs frequency

Fig. 6 - Maximum output current vs input voltage

Fig. 7 - Typical short circuit output current vs input voltage

Fig. 8 - Typical short circuit output current vs junction temperature

Fig. 9 - Typical dropout voltage vs output current

Fig. 10 - Typical quiescent drain current vs junction temperature

Fig. 11 - Typical quiescent drain current vs input voltage

Fig. 12 - Typical output resistance vs frequency

Line transient response
(I_o = 5 mA)

Turn on time
(I_o = 100 mA)

TYPICAL APPLICATIONS

Fig. 13 - Positive output voltage regulator

Fig. 14 - Negative output voltage regulator

TBA 625A

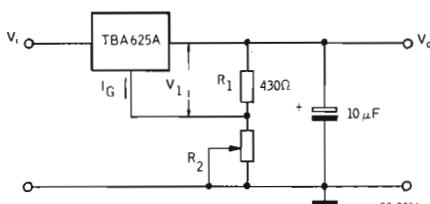
Fig. 15 - Adjustable output voltage regulator

Typical adjustable output voltage vs output current

Fig. 16 - PNP current boost circuit

Typical output voltage vs output current

TBA 625B

LINEAR INTEGRATED CIRCUIT

VOLTAGE REGULATOR

- OUTPUT CURRENT ≧ 100 mA
- TIGHT TOLERANCE for OUTPUT VOLTAGE
- LOAD REGULATION ≦ 1%
- RIPPLE REJECTION 54 dB TYPICAL
- OVERLOAD and SHORT CIRCUIT PROTECTION

The TBA 625B is an integrated monolithic 12 V voltage regulator in TO-39 metal case which can supply more than 100 mA. The device features high temperature stability, internal overload and short circuit protection, low output impedance and excellent transient response. The TBA 625B is intended for use as voltage supply for digital circuits with high noise immunity, linear integrated circuits and for any other industrial applications.

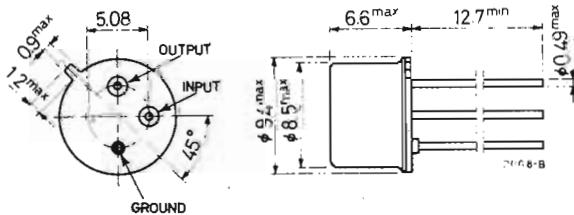
ABSOLUTE MAXIMUM RATINGS

V_i	Input voltage	27	V
P_{tot}	Power dissipation at $T_{amb} = 25\,°C$	0.75	W
	at $T_{case} = 25\,°C$	4	W
T_{stg}	Storage temperature	-55 to 150	°C
T_j	Junction temperature	175	°C
T_{op}	Operating temperature	0 to 70	°C

ORDERING NUMBER: TBA 625B X5

MECHANICAL DATA

Dimensions in mm

Ground connected to case

TBA 625B

SCHEMATIC DIAGRAM

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	37.5	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	200	°C/W

ELECTRICAL CHARACTERISTICS (T_j = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
V_o	Output voltage	V_i = 15 V to 27 V I_o = 5 mA C_L = 10 μF	11.4	12	12.6	V
$\frac{\Delta V_o}{V_o}$	Load regulation coefficient	V_i = 15 V to 27 V I_o = 5 mA to 100 mA C_L = 10 μF		0.3	1	%
I_o	Regulated current	V_i = 12 V $\frac{\Delta V_o}{V_o} \leq 1\%$	100	140		mA

ELECTRICAL CHARACTERISTICS (continued)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_o	Max. regulated current	V_i = 21 V	120	150	200	mA
R_o	Output resistance	V_i = 21 V I_o = 5 mA to 100 mA		0.1		Ω
$\frac{\Delta V_o}{V_o}$	Line regulation coefficient	V_i = 15 V to 27 V I_o = 5 mA C_L = 10 μF		0.2	0.5	%
SVR	Supply voltage rejection	V_i = 17 V ΔV_i = 4 V_{pp} I_o = 5 mA C_L = 10 μF f = 100 Hz		46	54	dB
e_N	Output noise voltage	V_i = 21 V I_o = 5 mA C_L = 10 μF B = 10 Hz to 100 kHz		150		μV
I_d	Quiescent drain current	V_i = 27 V I_o = 0	6	10	18	mA
$\frac{\Delta V_o}{\Delta T_{amb}}$	Voltage/temperature coefficient	V_i = 21 V I_o = 5 mA C_L = 10 μF T_{amb} = 0 to 70 °C		0.85		mV/°C
I_{sc}	Output short circuit current	V_i = 27 V V_o = 0		35	55	mA

TBA 625B

Fig. 1 - Typical output voltage vs output current

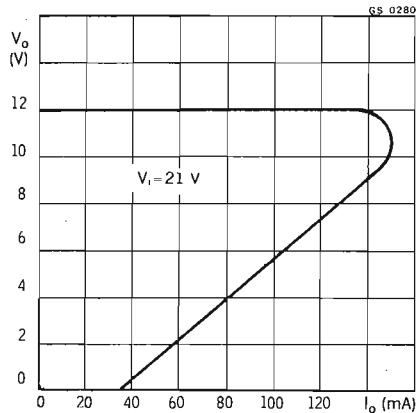
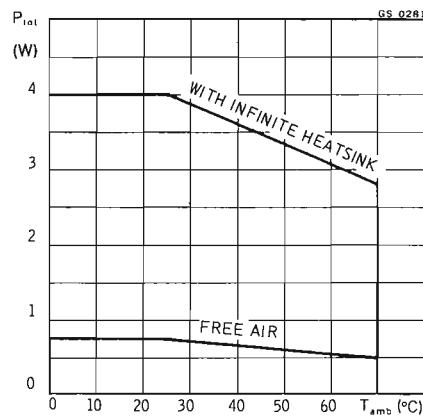



Fig. 2 - Power rating chart

Fig. 3 - Maximum output current vs junction temperature

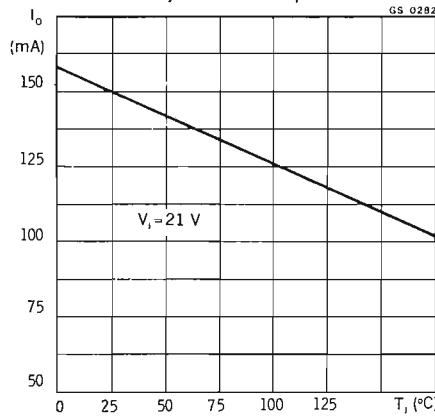



Fig. 4 - Typical ripple rejection vs regulated output current

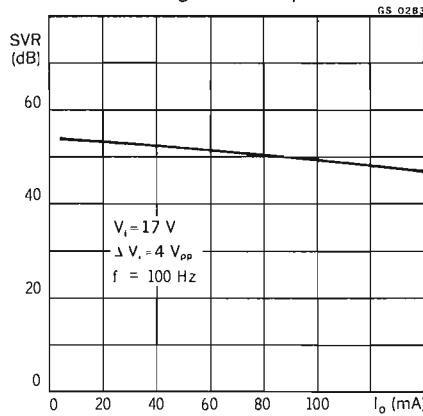



Fig. 5 - Typical ripple rejection vs frequency

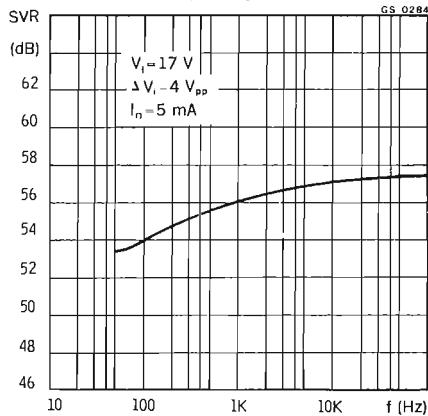



Fig. 6 - Maximum output current vs input voltage

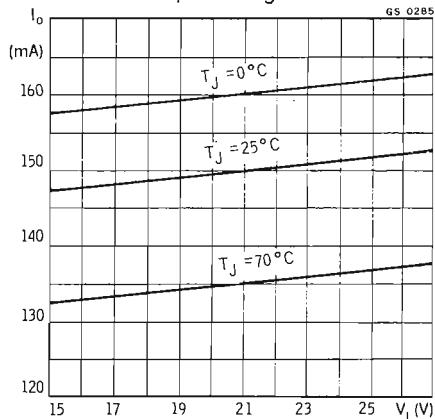



Fig. 7 - Typical short circuit output current vs input voltage

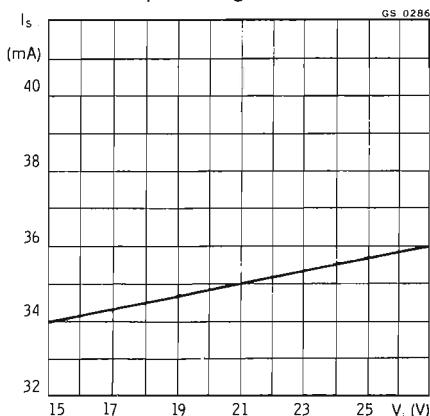



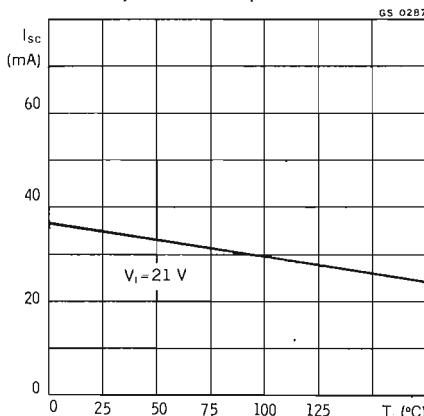
Fig. 8 - Typical short circuit output current vs junction temperature

TBA 625B

Fig. 9 - Typical dropout voltage vs output current

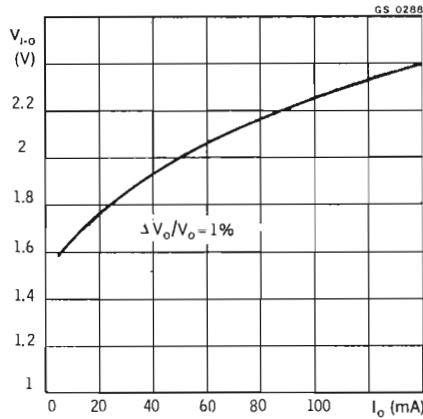



Fig. 10 - Typical quiescent drain current vs junction temperature

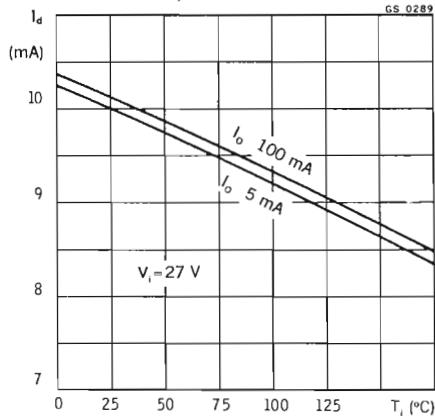



Fig. 11 - Typical quiescent drain current vs input voltage

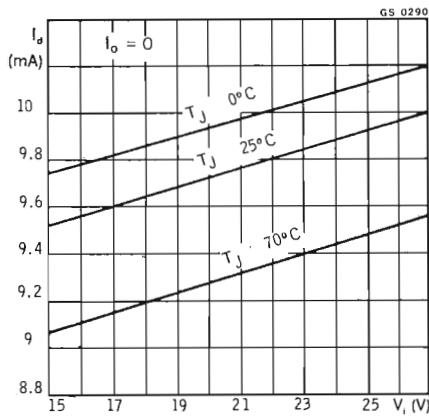



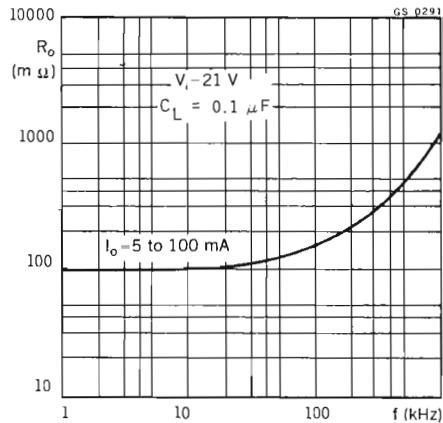
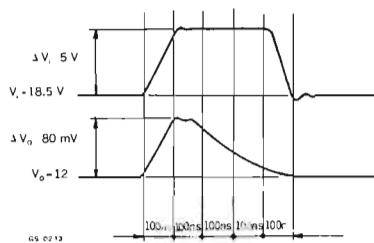
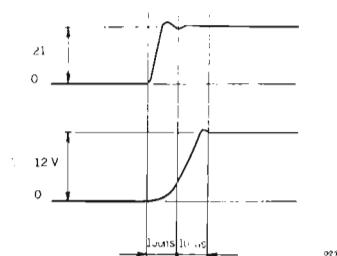
Fig. 12 - Typical output resistance vs frequency

Line transient response
(I_o = 5 mA)

Turn on time
(I_o = 100 mA)

TYPICAL APPLICATIONS

Fig. 13 - Positive output voltage regulator

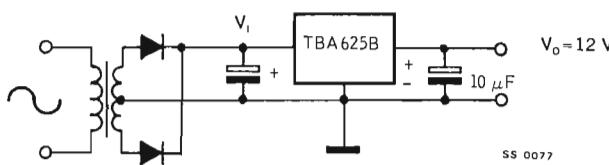



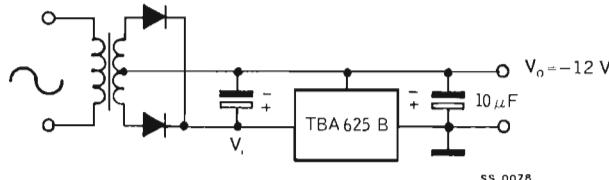
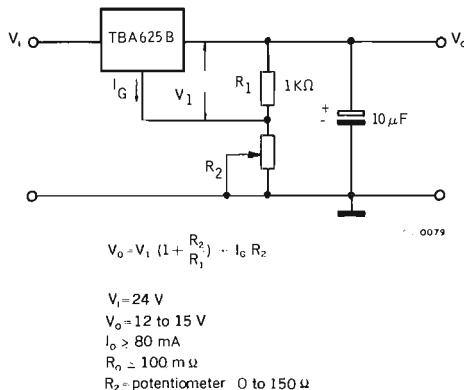
Fig. 14 - Negative output voltage regulator

TBA 625B

Fig. 15 - Adjustable output voltage regulator

Typical adjustable output voltage vs output current

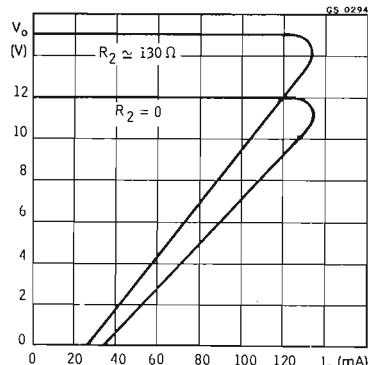
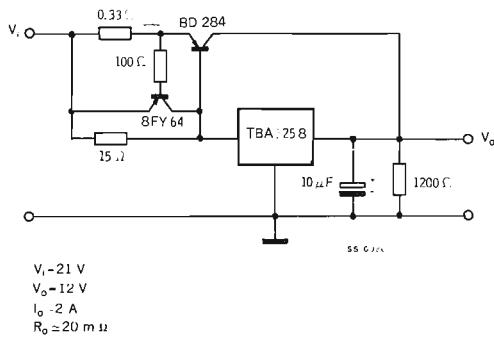
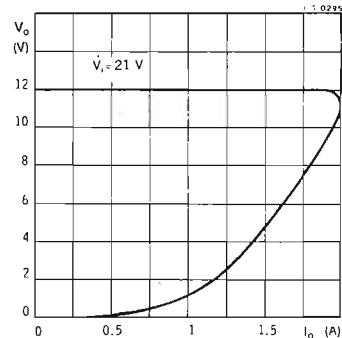



Fig. 16 - PNP current boost circuit

Typical output voltage vs output current

TBA 625C

LINEAR INTEGRATED CIRCUIT

VOLTAGE REGULATOR

- OUTPUT CURRENT ≥ 100 mA
- TIGHT TOLERANCE for OUTPUT VOLTAGE
- LOAD REGULATION ≤ 1%
- RIPPLE REJECTION 51 dB TYPICAL
- OVERLOAD and SHORT CIRCUIT PROTECTION

The TBA 625C is an integrated monolithic 15 V voltage regulator in TO-39 metal case which can supply more than 100 mA. The device features high temperature stability, internal overload and short circuit protection, low output impedance and excellent transient response. The TBA 625C is intended for use as voltage supply for digital circuits with high noise immunity, linear integrated circuits and for any other industrial applications.

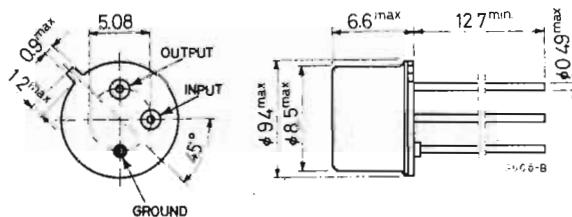
ABSOLUTE MAXIMUM RATINGS

V_i	Input voltage	27	V
P_{tot}	Power dissipation at $T_{amb} = 25\ °C$	0.75	W
	at $T_{case} = 25\ °C$	4	W
T_{op}	Storage temperature	-55 to 150	°C
T_j	Junction temperature	175	°C
T_{op}	Operating temperature	0 to 70	°C

ORDERING NUMBER: TBA 625C X5

MECHANICAL DATA

Dimensions in mm

Ground connected to case

TBA 625C

SCHEMATIC DIAGRAM

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	37.5	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	200	°C/W

ELECTRICAL CHARACTERISTICS (T_j = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
V_o	Output voltage	V_i = 18 V to 27 V I_o = 5 mA C_L = 10 μF	14.25	15	15.75	V
$\frac{\Delta V_o}{V_o}$	Load regulation	V_i = 18 V to 27 V I_o = 5 mA to 100 mA C_L = 10 μF		0.3	1	%
I_o	Regulated current	V_i = 24 V $\frac{\Delta V_o}{V_o} \leq 1\%$	100	140		mA

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_o	Max. regulated current	V_i = 24 V	120	150	200	mA
R_o	Output resistance	V_i = 24 V I_o = 5 mA to 100 mA		0.1		Ω
$\frac{\Delta V_o}{V_o}$	Line regulation	V_i = 18 V to 27 V I_o = 5 mA C_L = 10 μF		0.25	0.5	%
SVR	Supply voltage rejection	V_i = 20 V ΔV_i = 4 V_{pp} I_o = 5 mA C_L = 10 μF f = 100 Hz	46	51		dB
e_N	Output noise voltage	V_i = 24 V I_o = 5 mA C_L = 10 μF B = 10 Hz to 100 kHz		200		μV
I_d	Quiescent drain current	V_i = 27 V I_o = 0	6	10	18	mA
$\frac{\Delta V_o}{\Delta T_{amb}}$	Temperature coefficient	V_i = 24 V I_o = 5 mA C_L = 10 μF T_{amb} = 0 to 70 °C		1.5		mV/°C
I_{sc}	Output short circuit current	V_i = 27 V V_o = 0		30	50	mA

TBA 625C

Fig. 1 - Typical output voltage vs output current

Fig. 2 - Power rating chart

Fig. 3 - Maximum output current vs junction temperature

Fig. 4 - Typical ripple rejection vs regulated output current

Fig. 5 - Typical ripple rejection vs frequency

Fig. 6 - Maximum output current vs input voltage

Fig. 7 - Typical short circuit output current vs input voltage

Fig. 8 - Typical short circuit output current vs junction temperature

Fig. 9 - Typical dropout voltage vs output current

Fig. 10 - Typical quiescent drain current vs junction temperature

Fig. 11 - Typical quiescent drain current vs input voltage

Fig. 12 - Typical output resistance vs frequency

Line transient response
(I_o = 5 mA)

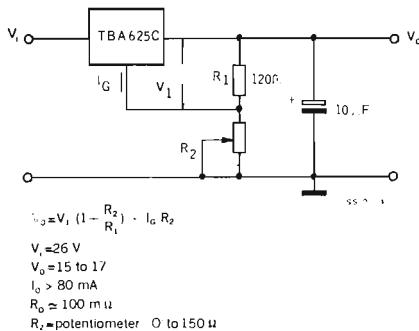
Turn on time
(I_o = 100 mA)

TYPICAL APPLICATIONS

Fig. 13 - Positive output voltage regulator

Fig. 14 - Negative output voltage regulator

TBA 625C

Fig. 15 - Adjustable output voltage regulator

Typical adjustable output voltage vs output current

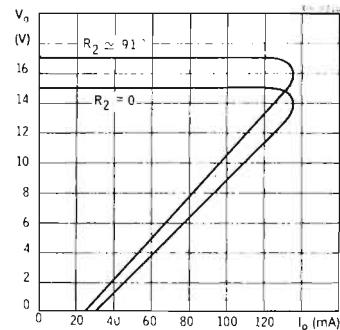
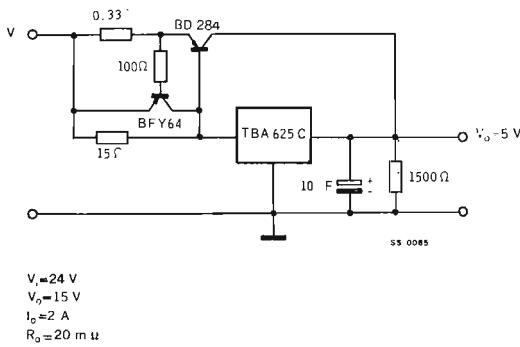
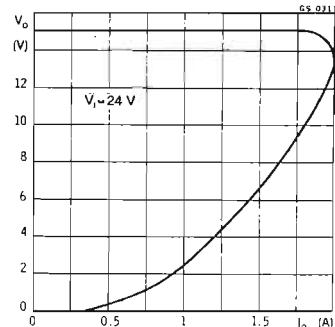



Fig. 16 - PNP current boost circuit

Typical output voltage vs output current

LINEAR INTEGRATED CIRCUIT

TBA 631

TV SOUND SECTION

- OUTPUT POWER 3 W (24 V - 16 Ω)
- LOW THRESHOLD LIMITING VOLTAGE
- LOW DISTORTION
- HIGH AM REJECTION
- SUPPLY VOLTAGE RANGING from 6 V to 18 V for IF STAGE and from 12 V to 27 V for POWER AMPLIFIER STAGE.

The TBA 631 is an integrated monolithic circuit in a 16-lead quad in-line plastic package with external heat-sink. It is especially designed as the whole sound section for TV receivers, from video preamplifier to load-speaker.
It combines the following functions: limiter amplifier, detector and audio power amplifier.

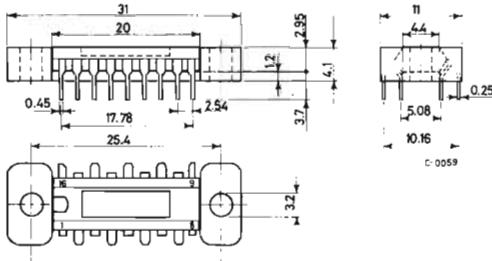
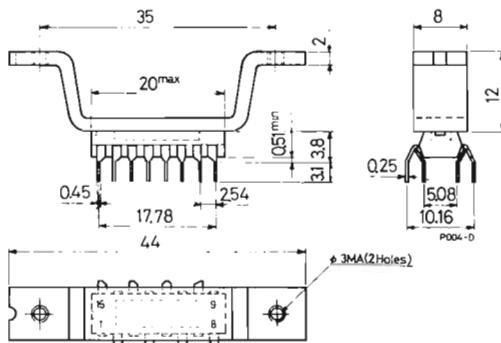
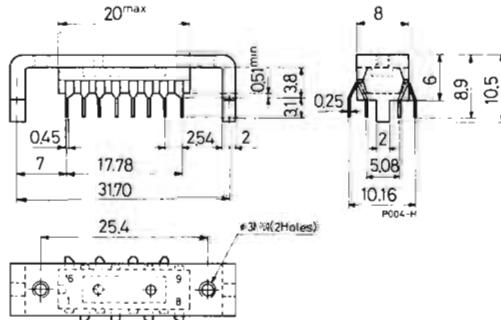
ABSOLUTE MAXIMUM RATINGS

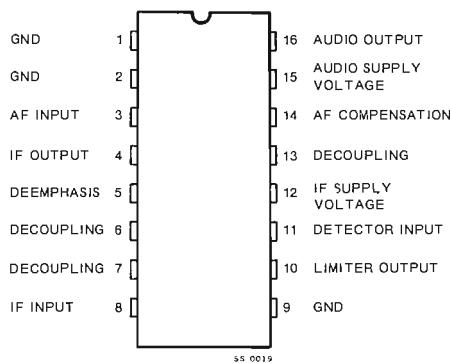
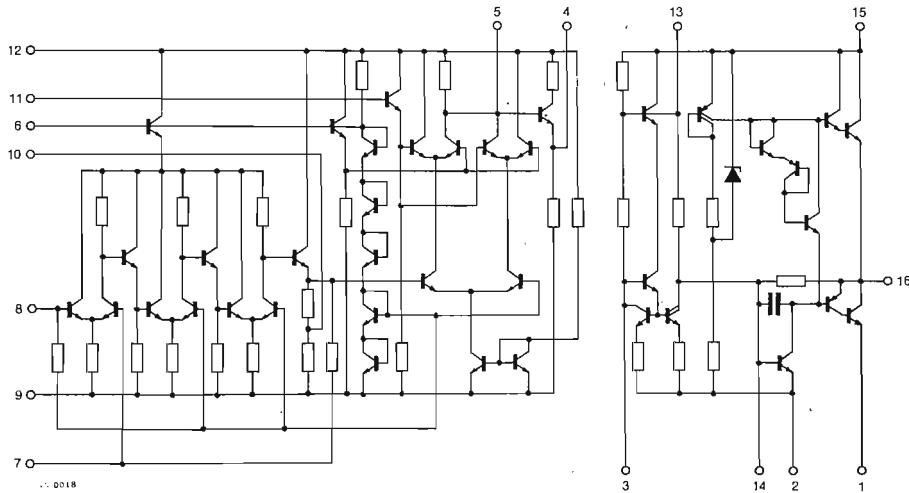
V_{s1}	Supply voltage (IF stage)	18	V
V_{s2}	Supply voltage (Power stage)	27	V
I_o	Output peak current	1	A
P_{tot}	Power dissipation at $T_{amb} \leq 25\ °C$	2	W
	at $T_{case} \leq 70\ °C$	4.5	W
T_{stg}, T_j	Storage and junction temperature	-55 to 150	°C

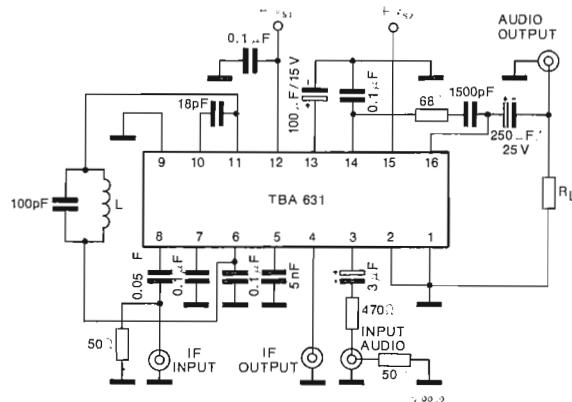
ORDERING NUMBERS:

TBA 631 A72 (for quad in-line plastic package with spacer)
TBA 631 A51 (for quad in-line plastic package with external bar)
TBA 631 A61 (for quad in-line plastic package with inverted external bar)

TBA 631

Quad in-line plastic package with spacer for TBA 631 A72 (see also "MOUNTING INSTRUCTIONS")

Quad in-line plastic package with external bar for TBA 631 A51

Quad in-line plastic package with inverted external bar for TBA 631 A61

TBA 631

CONNECTION DIAGRAM
(top view)

SCHEMATIC DIAGRAM

TBA 631

TEST CIRCUIT

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	17	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	63	°C/W

ELECTRICAL CHARACTERISTICS

(T_{amb} = 25 °C, V_{s1} = 12 V unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
IF STAGE						
I_d	Quiescent drain current			18		mA
$V_{i(threshold)}$	Input limiting voltage	f = 5.5 MHz f = 10.7 MHz		100 230		μV μV
V_o	Recovered output voltage	V_i = 10 mV f = 5.5 MHz f_m = 1 kHz Δf = ±25 kHz		1		V
d	Distortion	V_i = 10 mV f = 5.5 MHz f_m = 1 kHz Δf = ±25 kHz		1.8		%

ELECTRICAL CHARACTERISTICS (continued)

	Parameter	Test conditions	Min. Typ. Max.	Unit
AMR	Amplitude modulation rejection	V_i = 10 mV f = 5.5 MHz f_m = 1 kHz Δf = ±25 kHz m = 0.3	49	dB
Z_i	Input impedance at pin 8	f = 5.5 MHz f = 10.7 MHz	2.5 2	kΩ kΩ
Z_o	Output impedance at pin 4	f = 1 kHz	100	Ω

AUDIO POWER STAGE (R_L = 16 Ω unless otherwise specified)

	Parameter	Test conditions	Min. Typ. Max.	Unit
I_d	Quiescent drain current	V_{s2} = 18 V V_{s2} = 24 V	9 12	mA mA
P_o	Cutput power	d = 10% f = 1 kHz V_{s2} = 18 V V_{s2} = 24 V d = 1% f = 1 kHz G_v = 30 dB V_{s2} = 18 V V_{s2} = 24 V	 1.8 3 1.4 2.25	 W W W W
d	Distortion	P_o = 50 mW f = 1 kHz G_v = 30 dB V_{s2} = 18 V V_{s2} = 24 V	 0.3 0.2	 % %
I_d	Drain current	P_o = 3 W V_{s2} = 24 V P_o = 1.8 W V_{s2} = 18 V	200 165	mA mA

Fig. 1 - Typical relative audio output voltage (pin 4) vs RF input voltage

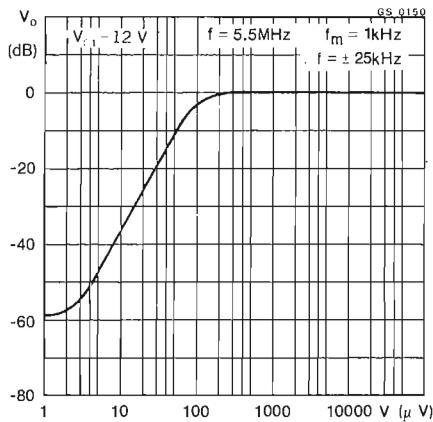



Fig. 2 - Typical AM rejection vs RF input voltage

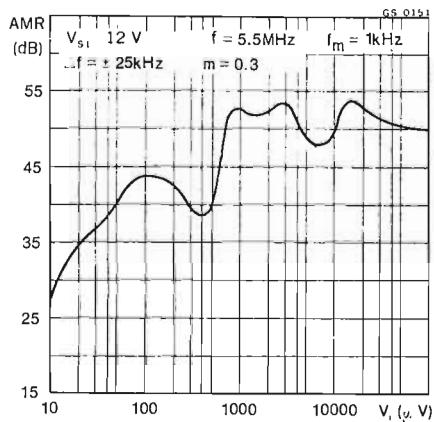



Fig. 3 - Typical output power of the AF amplifier vs supply voltage

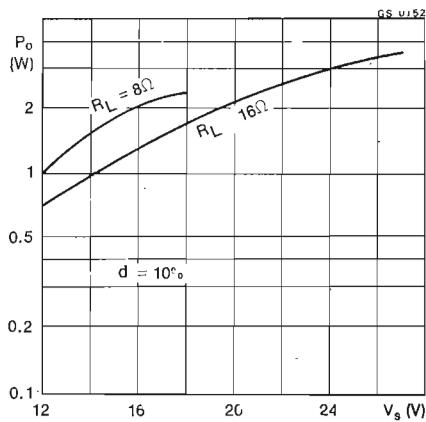



Fig. 4 - Typical distortion vs output power

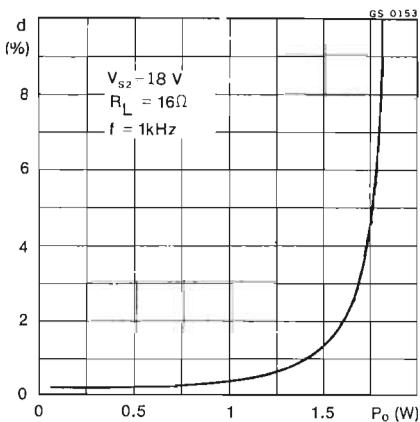



Fig. 5 - Typical distortion vs output power

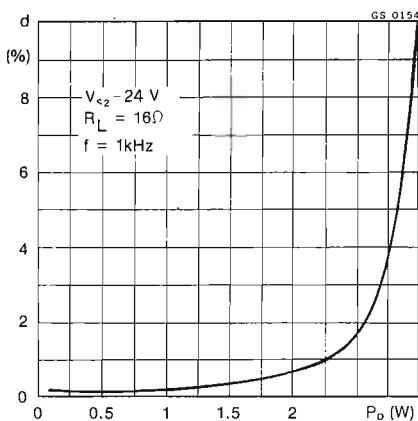



Fig. 6 - Typical relative voltage gain of the AF amplifiers vs frequency (see test circuit)

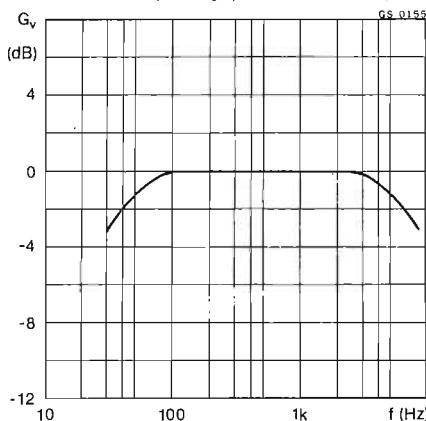



Fig. 7 - Typical output power of the AF amplifier vs input voltage (pin 3)

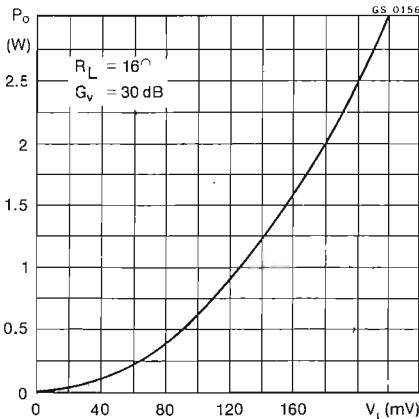



Fig. 8 - Typical power dissipation of TBA 631 vs output power

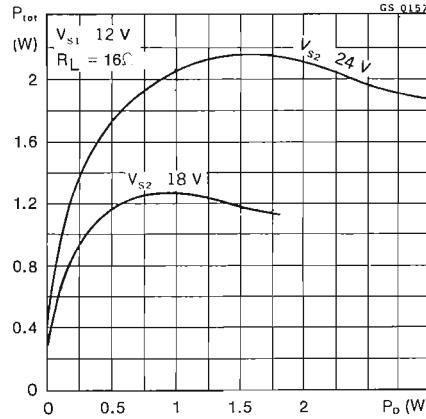



Fig. 9 - Typical efficiency vs output power

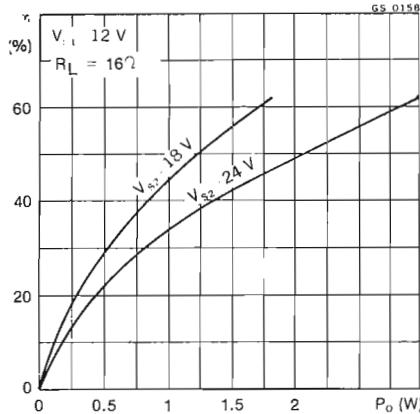



Fig. 10 - Typical drain current of the AF amplifier vs output power

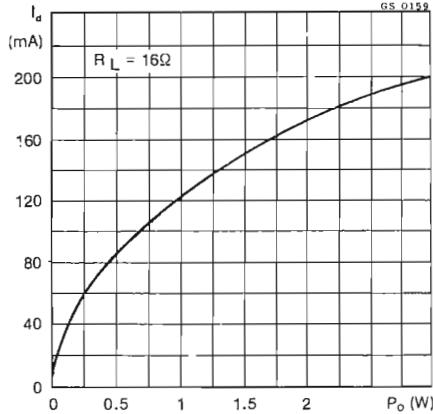



Fig. 11 - Maximum power dissipation vs AF amplifier supply voltage

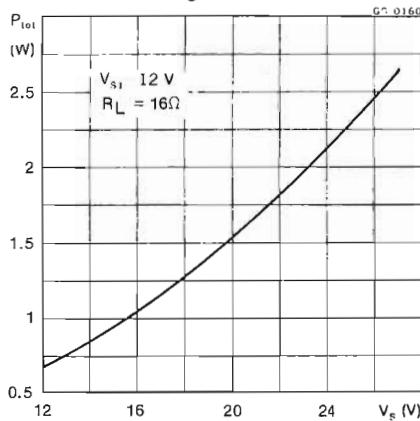
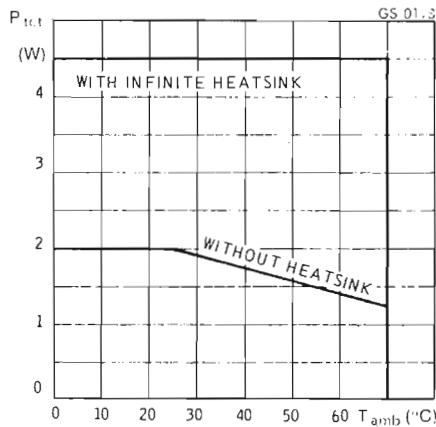
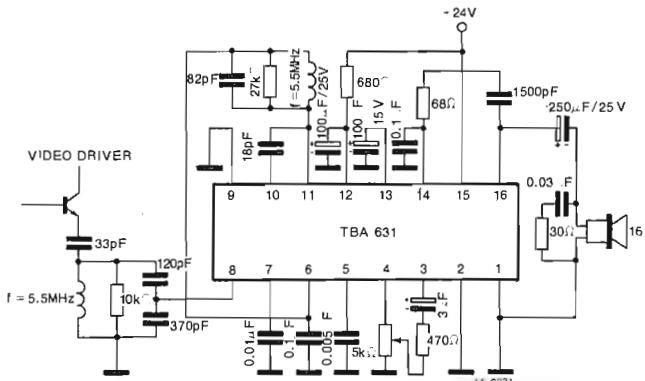



Fig. 12 - Power rating chart

TYPICAL APPLICATION

Sound section of a TV receiver.

MOUNTING INSTRUCTIONS

Heat-sinking with spacer.

Fig. 13

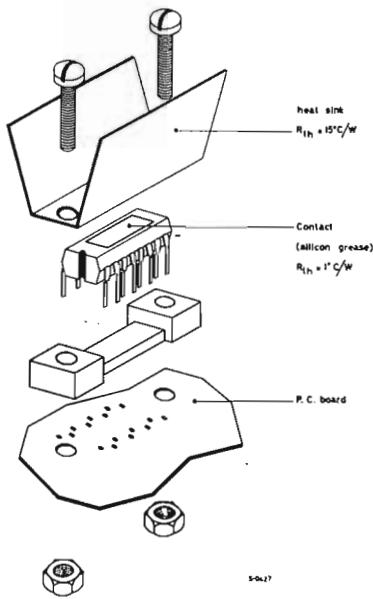



Fig. 13 - Shows a method of mounting the TBA 631 with the spacer, satisfactory both mechanically and from the point of view of heat dissipation. Better thermal contact between package and heat-sink can be obtained by using a small quantity of silicon grease. For heat dissipation the desired thermal resistance is obtained by fixing the elements shown to a heat-sink of suitable dimensions.

MOUNTING INSTRUCTIONS (continued)

Heat-sinking with external bar

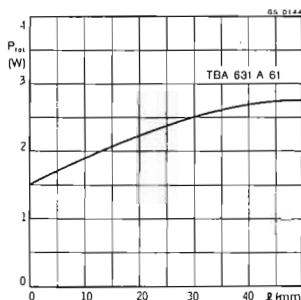
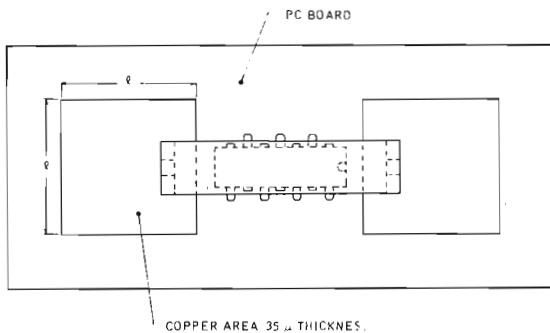
Power dissipation can be achieved by means of an additional external heat-sink fixed with two screws (both packages) or by soldering the pins of the external bar to suitable copper areas on the p.c. board (TBA 631 A61).

A. In the former case, the thermal resistance case-ambient of the added heat-sink can be calculated as follows:

$$R_{th} = \frac{(T_{jmax} - T_{amb}) - P_{tot} \cdot R_{th\ j\text{-}case}}{P_{tot}}$$

where:

T_{jmax} = Max junction temperature
T_{amb} = Ambient temperature
P_{tot} = Power dissipation
$R_{th\ j\text{-}case}$ = Thermal resistance junction-case

B. If copper areas on the p.c. board are used (TBA 631 A61) the diagrams enclosed give the maximum power dissipation as a function of copper area, with copper thickness 35 μ and ambient temperature 55 °C.

TBA 641A

LINEAR INTEGRATED CIRCUIT

AUDIO AMPLIFIER

- OUTPUT POWER 2.2 W (9 V - 4 Ω)
- LOW DISTORTION
- LOW QUIESCENT CURRENT
- SELF CENTERING BIAS
- HIGH INPUT IMPEDANCE

The TBA 641 A is a monolithic integrated circuit in a 14-lead quad in-line plastic package. It is particularly designed for use as audio power amplifier in portable radio receivers, tape recorders, record players and in industrial applications which require high output power, low distortion and high reliability performance.
Special features of the circuit include a low quiescent current, self centering bias operation at supply voltage ranging from 6 V to 12 V, direct coupling of the input. The circuit requires a minimum of external components.

ABSOLUTE MAXIMUM RATINGS

V_s	Supply voltage	12	V
V_i	Input voltage	-0.5 to $+V_s$	V
I_o	Output peak current	2	A
P_{tot}*	Power dissipation at $T_{amb} \leq 25$ °C	1.5	W
T_{stg}	Storage temperature	-40 to 150	°C
T_j	Junction temperature	150	°C

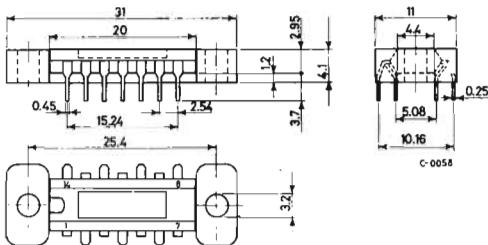
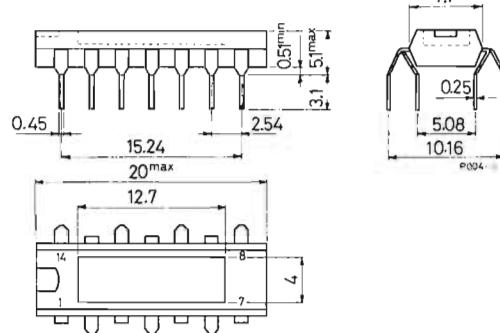
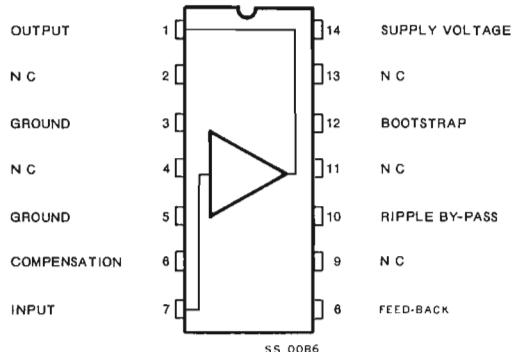
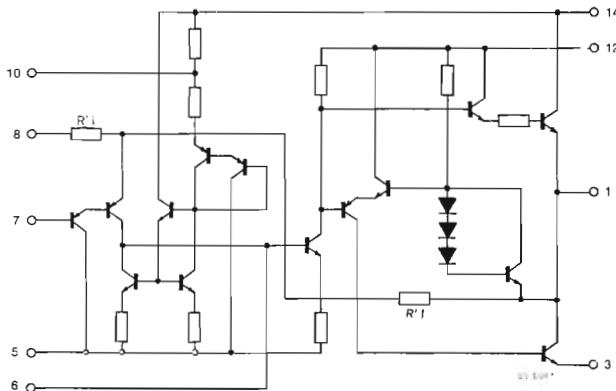
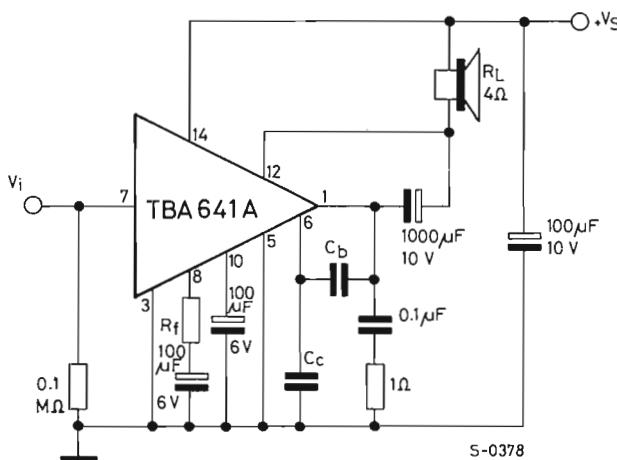
* P_{tot} value refers to TBA 641 A12

ORDERING NUMBERS:

TBA 641 A72 for quad in-line plastic package with spacer
TBA 641 A12 for quad in-line plastic package

TBA 641A

MECHANICAL DATA (Dimensions in mm)

Quad in-line plastic package with spacer for TBA 641 A72 (see also "MOUNTING INSTRUCTIONS")

Quad in-line plastic package for TBA 641 A12

CONNECTION DIAGRAM
(top view)

SCHEMATIC DIAGRAM

TEST AND APPLICATION CIRCUIT

TBA 641A

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	typ	13	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	typ	83	°C/W

ELECTRICAL CHARACTERISTICS

(See test circuit; $T_{amb} = 25\,°C$, $V_s = 9\,V$ and $R_L = 4\,\Omega$ unless otherwise specified)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_o	Quiescent output voltage (pin 1)		4	4.5	5	V
I_d	Total quiescent drain current	$P_o = 0$		8	18	mA
I_d	Quiescent drain current of output transistors	$P_o = 0$		6		mA
I_d	Drain current	$P_o = 2.2\,W$		340		mA
I_b	Bias current (pin 7)			100		nA
P_o	Output power	$d = 10\%$ $f = 1\,kHz$ $G_v = 46\,dB$	1.8	2.2		W
R'_f	Internal feedback resistance	See schematic diagram		7		kΩ
R'_i	Internal feedback resistance	See schematic diagram		35		Ω
Z_i	Input impedance (pin 7)	$f = 1\,kHz$ $G_v = 46\,dB$		3		MΩ
d	Distortion	$f = 1\,kHz$ $G_v = 46\,dB$ $P_o = 50\,mW$ $P_o = 1\,W$		 0.6 0.6		 % %
G_v	Voltage gain	$R_f = 0$		46		dB
e_N	Input noise voltage	$R_s = 22\,k\Omega$ $B = 10\,kHz$		2.5		µV

Fig. 1 - Typical output power vs supply voltage

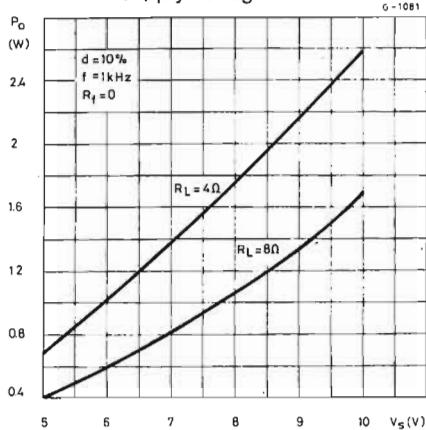



Fig. 2 - Typical distortion vs output power

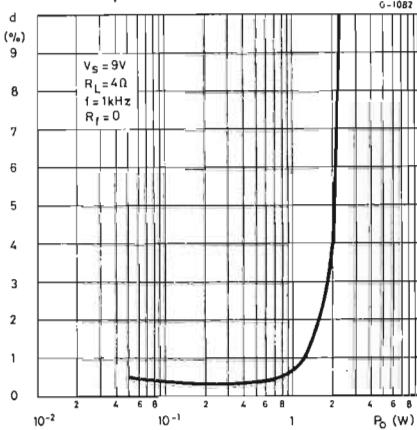



Fig. 3 - Typical voltage gain vs feedback resistance (R_f)

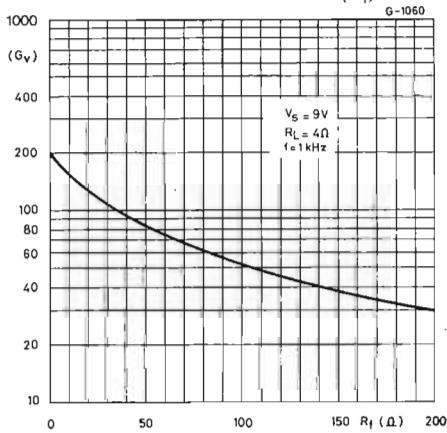



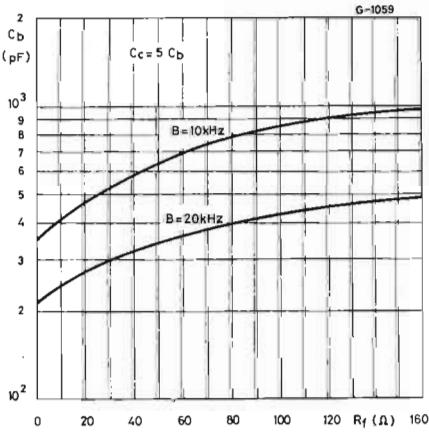
Fig. 4 - Typical value of C_b vs R_f for various values of B

TBA 641A

Fig. 5 - Typical output power vs input voltage

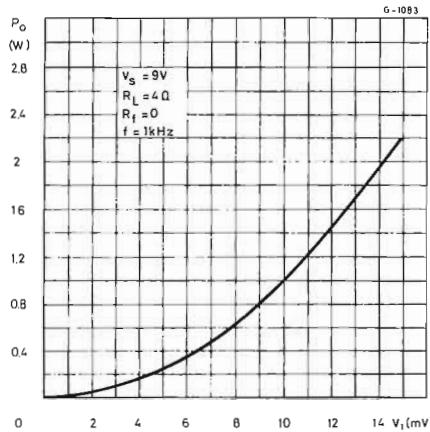



Fig. 6 - Typical power dissipation and efficiency vs output power

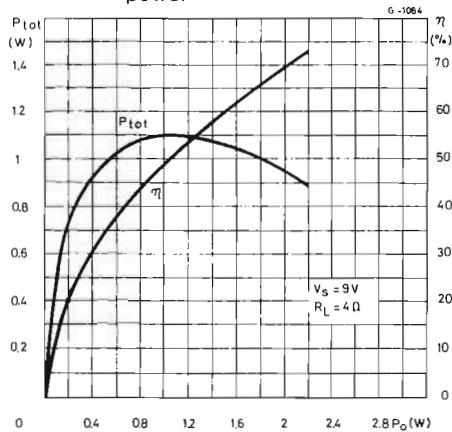



Fig. 7 - Typical drain current vs output power

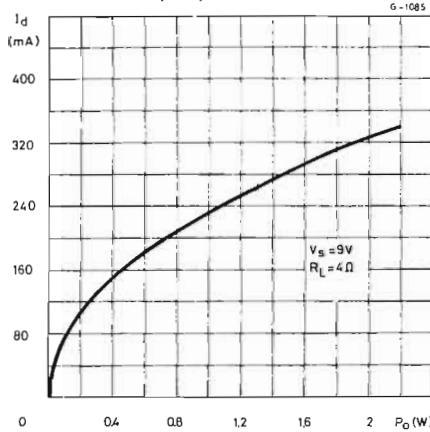
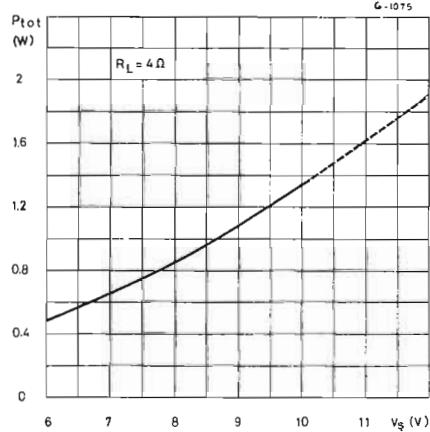



Fig. 8 - Maximum power dissipation *

* The dotted line refers to TBA 641 A72 with additional heat-sink.

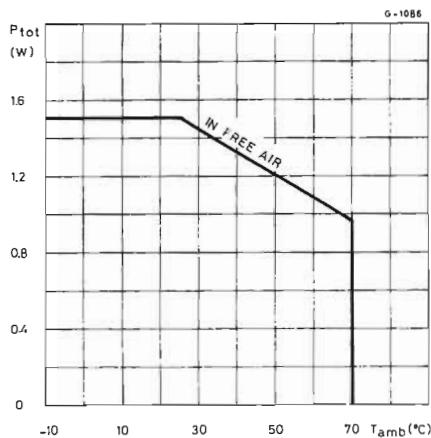



Fig. 9 - Power rating chart

Fig. 10 - Typical quiescent drain current vs supply voltage

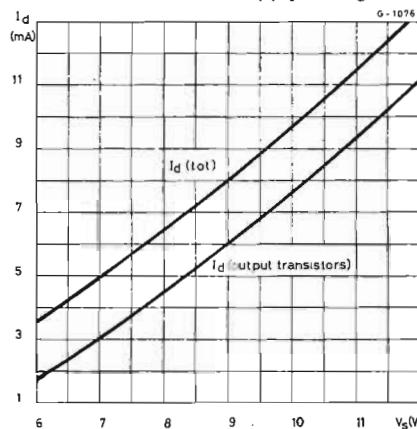



Fig. 11 - Typical quiescent drain current vs ambient temperature

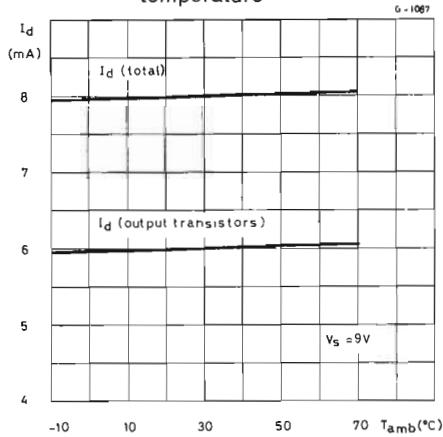



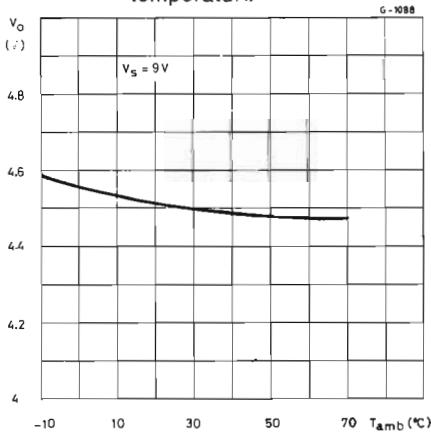
Fig. 12 - Typical quiescent output voltage vs ambient temperature

TBA 641A

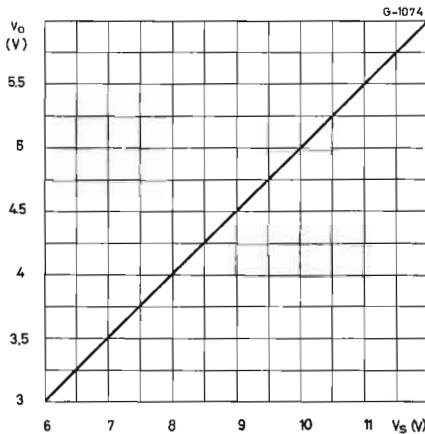
Fig. 13 - Typical quiescent output voltage vs supply voltage

TYPICAL APPLICATION

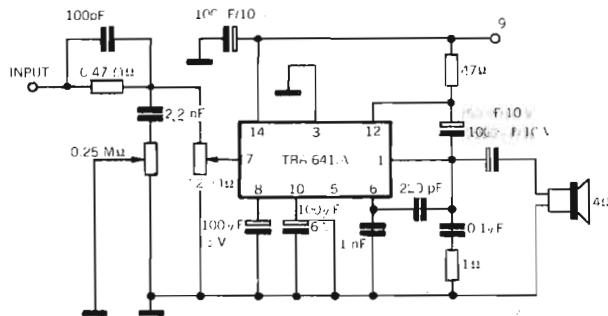
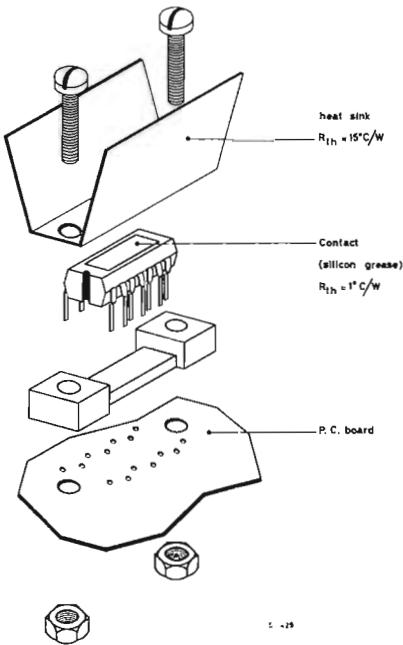
Fig. 14 - Portable record-player amplifier

MOUNTING INSTRUCTIONS

Fig. 15 shows a method of mounting the TBA 641 A with the spacer, satisfactory both mechanically and from the point of view of heat dissipation. Better thermal contact between package and heat-sink can be obtained by using a small quantity of silicon grease. For heat dissipation the desired thermal resistance is obtained by fixing the elements shown to a heat-sink of suitable dimensions.

Fig. 15

LINEAR INTEGRATED CIRCUIT

TBA 641B

AUDIO AMPLIFIER

- OUTPUT POWER 4.5 W (14 V - 4 Ω)
- LOW DISTORTION
- LOW QUIESCENT CURRENT
- HIGH INPUT IMPEDANCE

The TBA 641 B is a monolithic integrated circuit in a 14-lead quad in-line plastic package. It is particularly designed for use as audio power amplifier in radio and television receivers, and in industrial applications which require high output power, low distortion and high reliability performance. Special features of the circuit include a low quiescent current, self centering bias for operation at supply voltage ranging from 6 V to 16 V, direct coupling of the input. The circuit requires a minimum of external components.

ABSOLUTE MAXIMUM RATINGS

V_s	Supply voltage (no signal)	18	V
V_s	Operating supply voltage	16	V
V_I	Input voltage	-0.5 to $+V_s$	V
I_o	Peak output current	2.5	A
P_{tot}*	Power dissipation at $T_{amb} = 25\ °C$	2.3	W
	$T_{amb} = 70\ °C$	1.45	W
	$T_{case} = 70\ °C$	6	W
T_{stg}, T_j	Storage and junction temperature	-40 to 150	°C

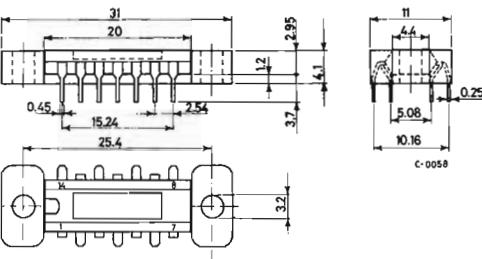
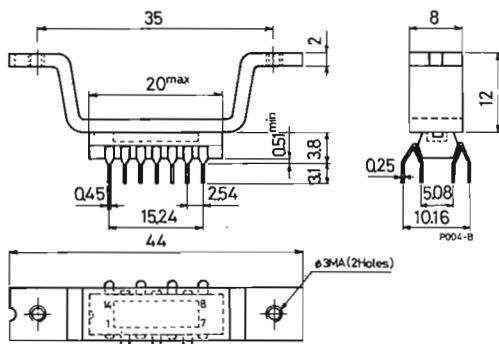
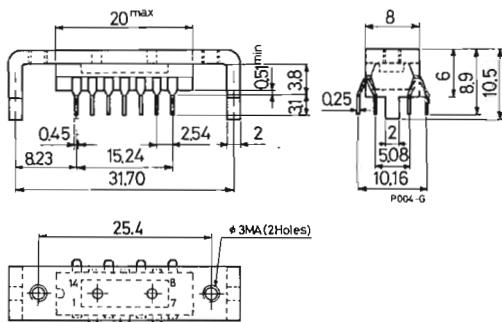
* P_{tot} values refer to TBA 641 BX1 and TBA 641 B11.

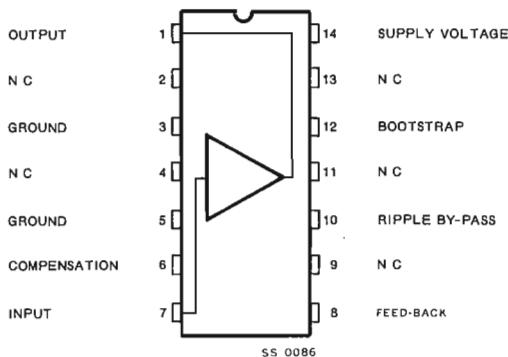
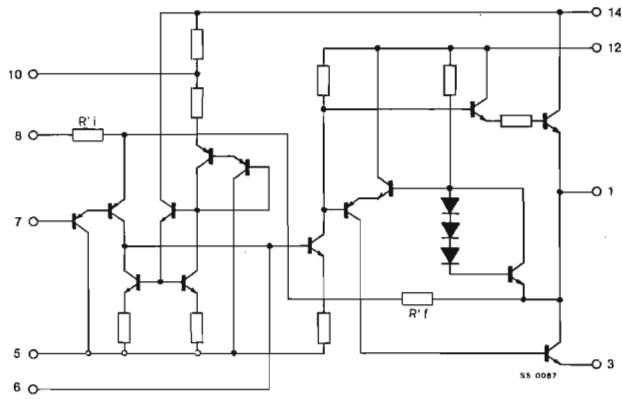
ORDERING NUMBERS:

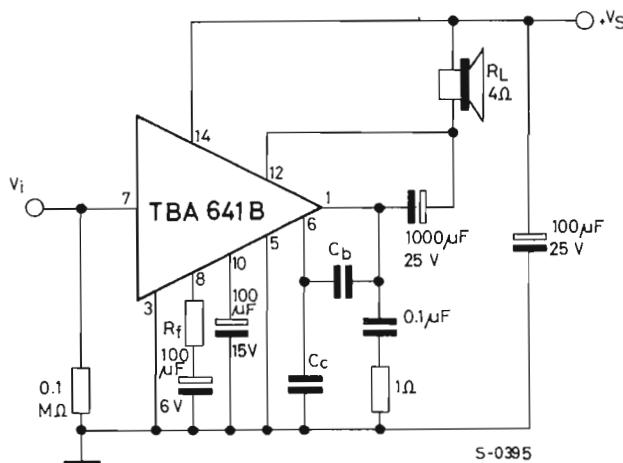
TBA 641 B72 for quad in-line plastic package with spacer
TBA 641 BX1 for quad in-line plastic package with external bar
TBA 641 B11 for quad in-line plastic package with inverted external bar

TBA 641B

MECHANICAL DATA (Dimensions in mm)

Quad in-line plastic package with spacer for TBA 641 B72 (see also "MOUNTING INSTRUCTIONS")

Quad in-line plastic package with external bar for TBA 641 BX1

Quad in-line plastic package with inverted external bar for TBA 641 B11

TBA 641B

CONNECTION DIAGRAM

SCHEMATIC DIAGRAM

TBA 641B

TEST AND APPLICATION CIRCUIT

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	typ	13	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	typ	55	°C/W

ELECTRICAL CHARACTERISTICS

(See test circuit; T_{amb} = 25 °C, V_s = 14 V and R_L = 4 Ω unless otherwise specified)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_o	Quiescent output voltage (pin 1)		6.5	7	8	V
I_d	Total quiescent drain current	$P_o = 0$		16	32	mA
I_d	Quiescent drain current of output transistors	$P_o = 0$		13		mA
I_d	Drain current	P_o = 4.5 W		485		mA
I_b	Bias current (pin 7)			250		nA

ELECTRICAL CHARACTERISTICS (continued)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
P_o	Output power	d = 10% f = 1 kHz G_v = 46 dB	4	4.5		W
R'_f	Internal feedback resistance	See schematic diagram		7		kΩ
R'_i	Internal feedback resistance	See schematic diagram		35		Ω
Z_i	Input impedance (pin 7)	f = 1 kHz G_v = 46 dB		3		MΩ
d	Distortion	f = 1 kHz G_v = 46 dB P_o = 50 mW P_o = 2 W		 0.3 0.8		 % %
G_v	Voltage gain	R_f = 0		46		dB
e_N	Input noise voltage	R_s = 22 kΩ B = 10 kHz		3.4		μV

Fig. 1 - Typical output power vs supply voltage

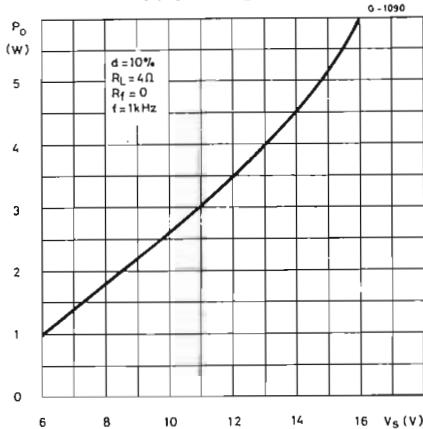



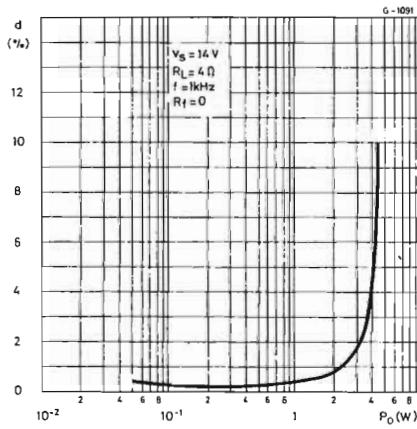
Fig. 2 - Typical distortion vs output power

TBA 641B

Fig. 3 - Typical voltage gain vs feedback resistance (R_f)

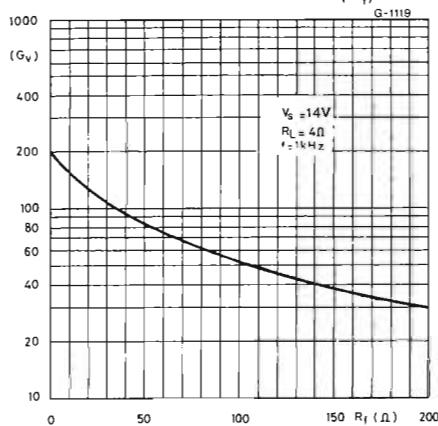



Fig. 4 - Typical value of C_b vs R_f for various values of B

Fig. 5 - Typical output power vs input voltage

Fig. 6 - Typical power dissipation and efficiency vs output power

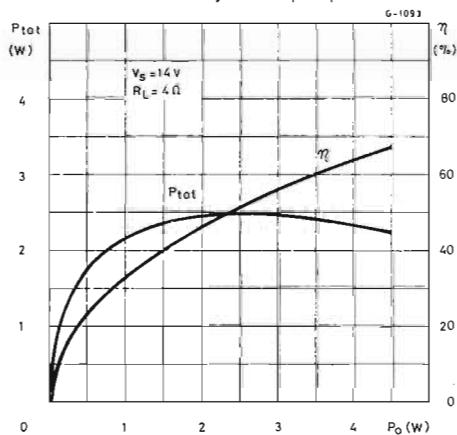



Fig. 7 - Typical drain current vs output power

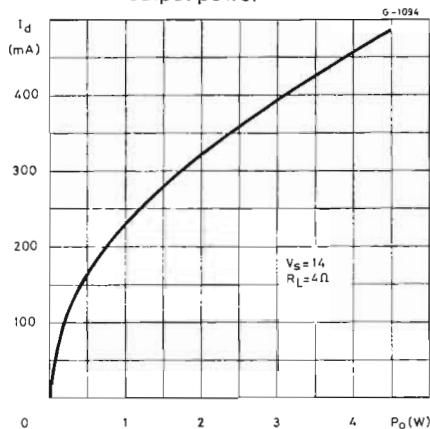



Fig. 8 - Maximum power dissipation vs supply voltage

Fig. 9 - Power rating chart

Fig. 10 - Typical quiescent drain current vs supply voltage

Fig. 11 - Typical quiescent drain current vs ambient temperature

Fig. 12 - Typical quiescent output voltage vs ambient temperature

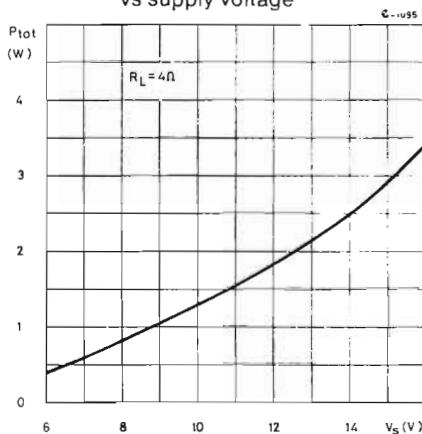
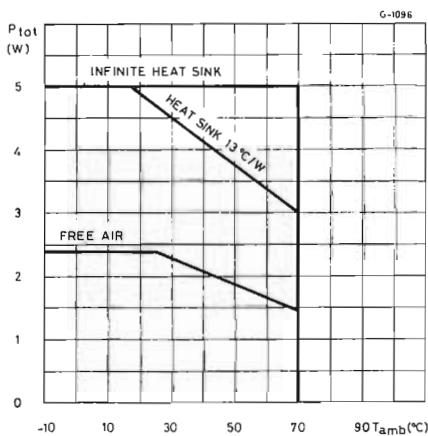
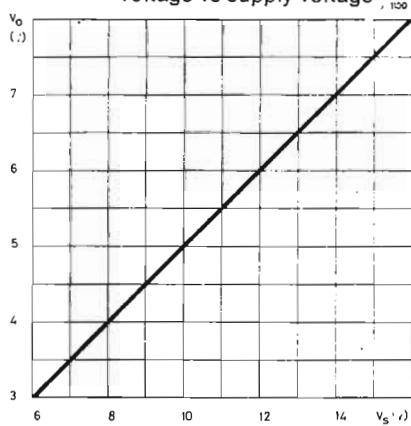



Fig. 13 - Typical quiescent output voltage vs supply voltage

TBA 641B

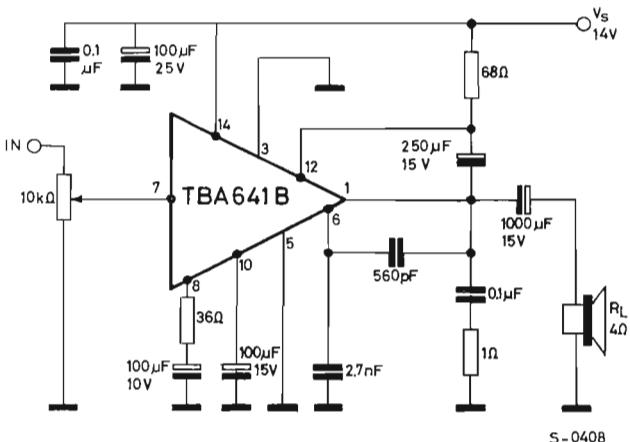
TYPICAL APPLICATION

MOUNTING INSTRUCTIONS

Fig. 14

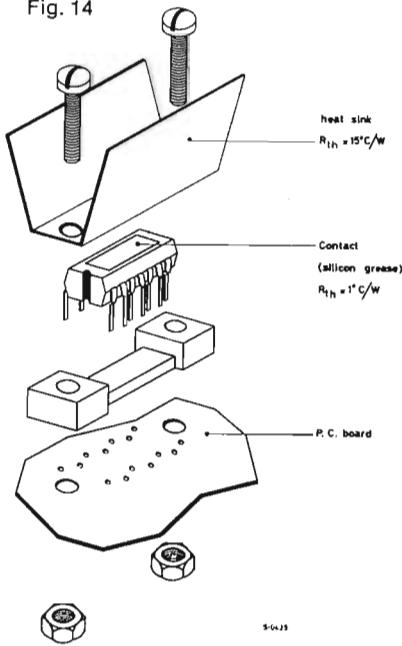



Fig. 14 shows a method of mounting the TBA 641 B with the spacer, satisfactory both mechanically and from the point of view of heat dissipation. Better thermal contact between package and heat-sink can be obtained by using a small quantity of silicon grease. For heat dissipation the desired thermal resistance is obtained by fixing the elements shown to a heat-sink of suitable dimensions.

MOUNTING INSTRUCTIONS (continued)

Power dissipation can be achieved by means of an additional external heat-sink fixed with two screws (both packages) or by soldering the pins of the external bar to suitable copper areas on the p.c. board (TBA 641 B11)

A. In the former case, the thermal resistance case-ambient of the added heat-sink can be calculated as follows:

$$R_{th} = \frac{{}_{jmax} - T_{amb}) - P_{tot} \cdot R_{th\ j\text{-}case}}{P_{tot}}$$

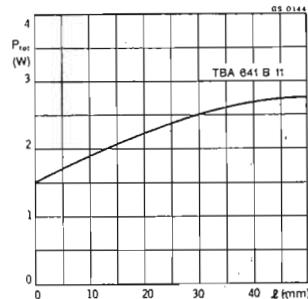
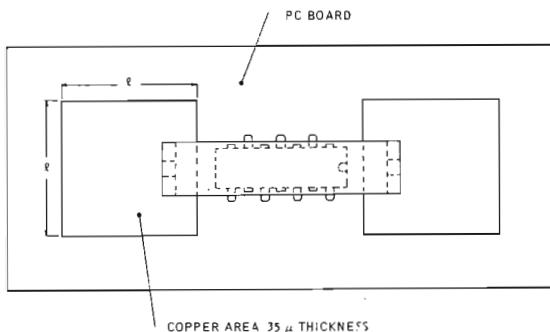
where:

T_{jmax} = Max junction temperature

T_{amb} = Ambient temperature

P_{tot} = Power dissipation

$R_{th\ j\text{-}case}$ = Thermal resistance junction-case

B. If copper areas on the p.c. board are used (TBA 641 B11) the diagrams enclosed give the maximum power dissipation as a function of copper area, with copper thickness 35 μ and ambient temperature 55 °C.

TBA 651

LINEAR INTEGRATED CIRCUIT

TUNER AND IF AMPLIFIER FOR AM RADIO

- AUDIO OUTPUT VOLTAGE 0.6 V
- LOW NOISE and HIGH GAIN
- WIDE VOLTAGE SUPPLY RANGE 4.5 V to 18 V
- HIGH SIGNAL HANDLING CAPABILITY 1 V

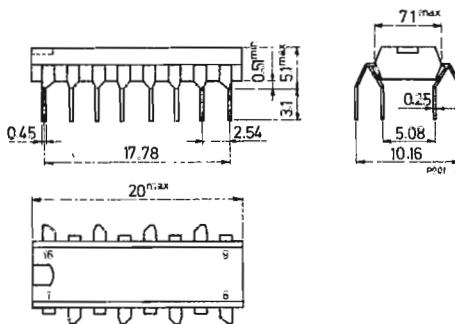
The TBA 651 is a monolithic integrated circuit in a 16-lead dual in-line plastic package which processes the high frequency signal from antenna to detector in AM receivers. It is particularly intended for car radios and high quality radio receivers.
The TBA 651 consists of five stages: RF amplifier, mixer, oscillator, IF amplifier and AGC control. It features wide voltage supply range (4.5 to 18 V), high gain, low noise and high sensitivity.

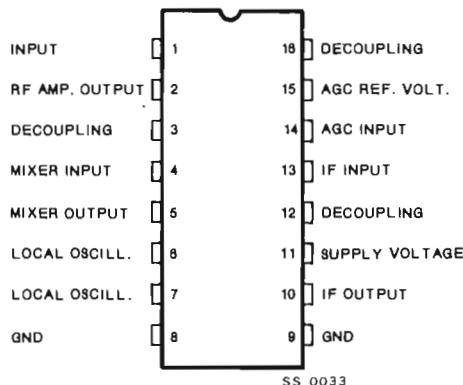
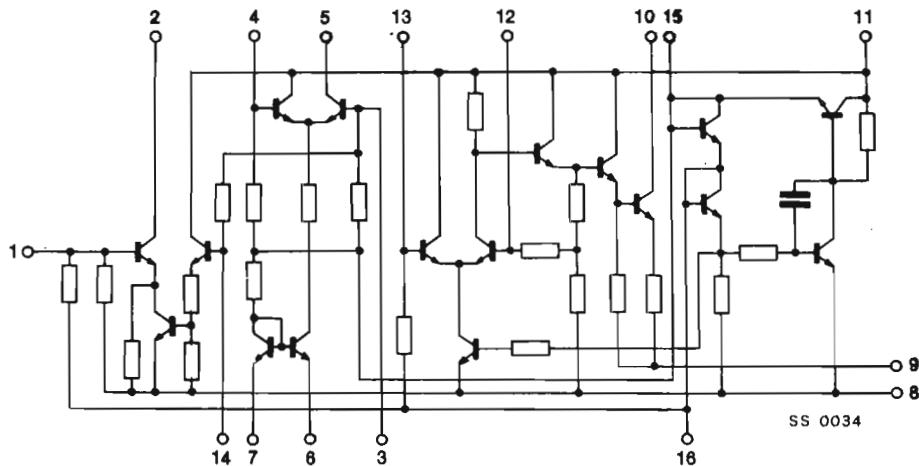
ABSOLUTE MAXIMUM RATINGS

V_s	Supply voltage	18	V
P_{tot}	Power dissipation at $T_{amb} \leq 80$ °C	250	mW
T_{stg}	Storage temperature	-55 to 150	°C
T_{op}	Operating temperature	-20 to 80	°C

ORDERING NUMBER: TBA 651

MECHANICAL DATA

Dimensions in mm

TBA 651

CONNECTION DIAGRAM
(top view)

SCHEMATIC DIAGRAM

TBA 651

TEST CIRCUIT (f = 1.6 MHz)

ELECTRICAL CHARACTERISTICS

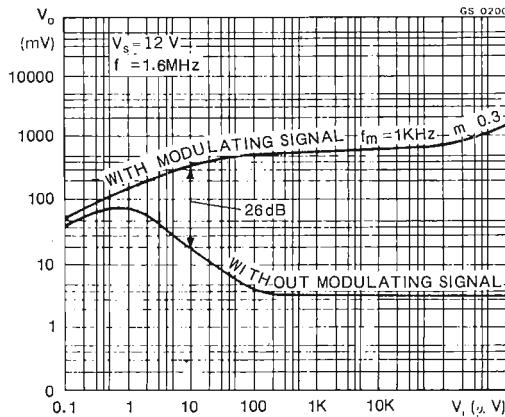
(T_{amb} = 25 °C, V_s = 12 V unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_d	Quiescent drain current			11.5		mA
V_i	Input voltage at pin 1	signal to noise ratio = 26 dB		10		μV
		d = 5% f = 1.6 MHz f_m = 1 kHz m = 0.8		100		mV
V_o	Recovered audio output voltage	f = 1.6 MHz f_m = 1 kHz m = 0.3 V_i = 100 μV V_i = 1.5 μV		0.5 180		V mV

TBA 651

ELECTRICAL CHARACTERISTICS (continued)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_i	Signal handling capability at pin 1			1		V
	AGC range	for 10 dB expansion of output voltage		80		dB
R_i	rf amplifier input resistance at pin 1	f = 1.6 MHz		1.4		kΩ
R_i	Mixer input resistance at pin 4	f = 1.6 MHz		2.5		kΩ
R_i	IF amplifier input resistance at pin 13	f = 455 kHz		4		kΩ

Fig. 1 - Typical output voltage vs input voltage

TBA 780

LINEAR INTEGRATED CIRCUIT

WIDE-BAND AMPLIFIER, FM DETECTOR, AUDIO PREAMPLIFIER/DRIVER

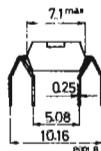
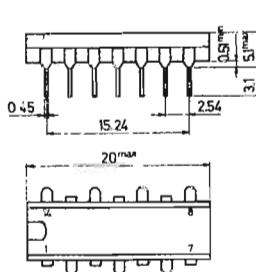
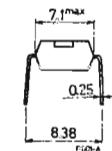
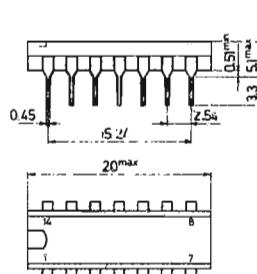
The TBA 780 provides, in a single monolithic silicon chip, a major subsystem for the sound section of TV receivers in a 14-lead quad in-line or dual in-line plastic package. As shown in the schematic diagram the TBA 780 contains a multistage wide-band IF amplifier/limiter section, active filter, an FM-detector stage, electronic attenuator, a Zener diode regulated power supply section and AF amplifier section specifically designed to directly drive an NPN power transistor or high-transconductance tube.
In the TBA 780, the demodulation can be effected by a single tuned discriminator coil (differential peak detector).
Because of the circuit beeing so inclusive, a minimum number of external components is required. A particular feature of the TBA 780 is the electronic attenuator, which performs the conventional volume control function.

ABSOLUTE MAXIMUM RATINGS

→	I_s	Supply current (pin 5)	50 mA
→	I_o	Output current (pin 12)	6 mA
	V_i	Input-signal voltage (between pins 1 and 2)	±3 V
	P_{tot}	Total power dissipation: at $T_{amb} \leq 25\,°C$	850 mW
→	T_{stg}	Storage temperature	-25 to 150 °C
→	T_{op}	Operating temperature	0 to 85 °C

ORDERING NUMBERS: TBA 780 X2 for quad in-line plastic package
TBA 780 X7 for dual in-line plastic package

MECHANICAL DATA

Dimensions in mm

TBA 780 X2 **TBA 780 X7**

TBA 780

THERMAL DATA

→ $R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	typ.	150	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C, DC volume control P2 = 0 and V_S = +30 V applied to terminal 5 through a 620 Ω resistor, unless otherwise specified)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit	Fig.
I_5	Supply current	V_S = 9 V (applied direct. to pin 5)	10	16	24	mA	—
$V_{i(threshold)}$	Input limiting voltage (pin 2)	f = 5.5 MHz f_m = 1 kHz Δf = ±50 kHz		200	400	μV	—
V_o	Recovered audio voltage (pin 8)	V_i = 100 mV f = 5.5 MHz f_m = 1 kHz Δf = ±50 kHz	0.5	0.75		V_{rms}	3
d	Distortion (pin 8)			0.9	2	%	
V_o	Audio output voltage (pin 12)	d = 5% f = 1 kHz	2	2.5		V_{rms}	4
→ V_o	DC output voltage (pin 12)		8.5		11.75	V	—
	DC volume control range	P_2 = ∞	60	80		dB	3
	Max. play-through voltage			0.075	1	mV	
R_i	Input resistance (pin 2)	f = 5.5 MHz		17		kΩ	—
R_o	Output resistance (pin 9)			3.25		kΩ	

ELECTRICAL CHARACTERISTICS (continued)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit	Fig.
R_o	Output resistance (pin 12)	f = 1 kHz		270		Ω	—
R_o	Output resistance (pin 7)	f = 1 kHz		7.5		kΩ	—
R_o	Output resistance (pin 8)	f = 1 kHz		300		Ω	—
C_i	Input capacitance (pin 2)	f = 5.5 MHz		4		pF	—
C_o	Output capacitance (pin 9)	f = 5.5 MHz		7.5		pF	—
→ G_v	Audio voltage gain	f = 1 kHz V_i = 0.1 V	17.5	20		dB	4
P_{tot}	Total power dissipation		343	370	400	mW	—
AMR	Amplitude modulation rejection	f = 5.5 MHz	40	50		dB	3

TBA 780

SCHEMATIC DIAGRAM

Fig. 1

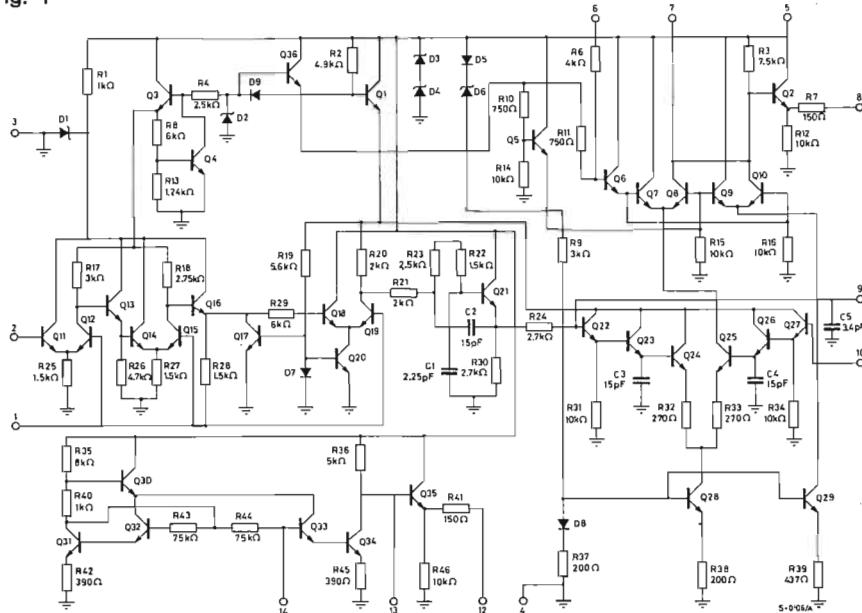
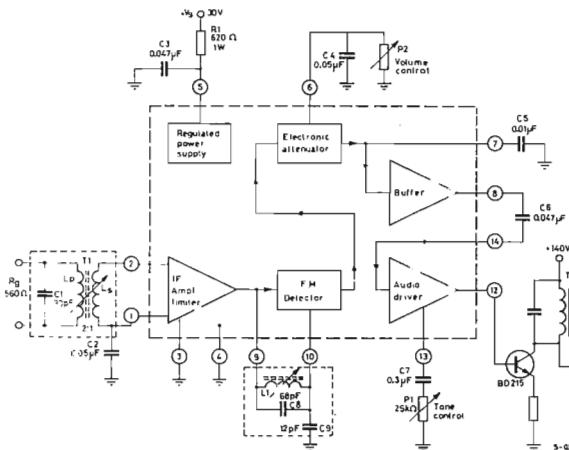



Fig. 2 - Typical circuit utilizing the TBA 780 and BD 215 transistor

1) T_1 = 5.5 MHz transformer

L_P = 5.5 μH; Q_O=80; 19 turns Ø 0.15 mm silk-covered copper wire with powdered-iron core

L_S = 9 turns Ø 0.15 mm

2) T_2 = Audio output transformer:

The dimensions of the transformer and of the circuit parameters are to be evaluated on the basis of the output power desired and of the load to be used

3) L_1 = Single tuned discriminator coil: 12 μH; Q_O= 50 (58 turns Ø 0.08 mm with powdered-iron core)

Fig. 3 - Input limiting voltage, AM rejection, recovered audio, total harmonic distortion, maximum attenuation, maximum "play-through" test circuit

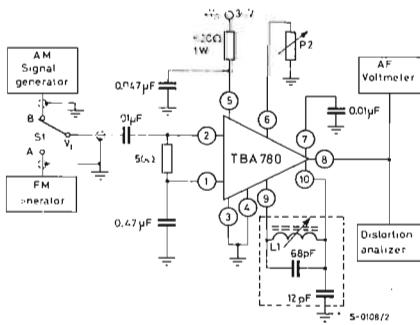



Fig. 4 - Audio voltage gain (undistorted output) test circuit

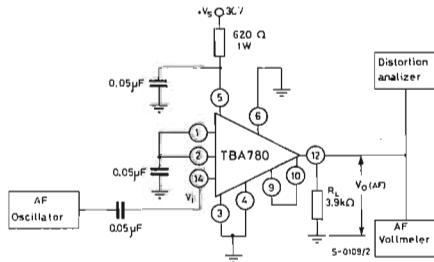



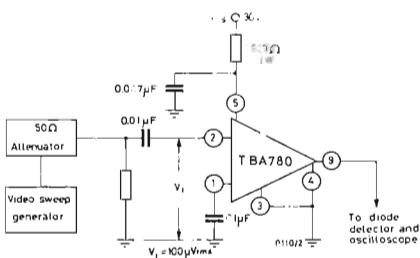
Fig. 5 - IF amplifier voltage gain test circuit

TBA 780

Fig. 6 - Typical IF amplifier voltage gain

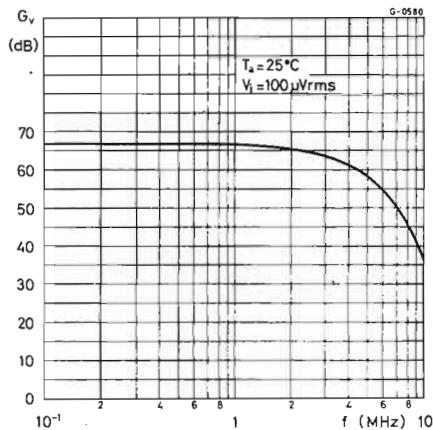



Fig. 7 - Typical AF amplifier voltage gain

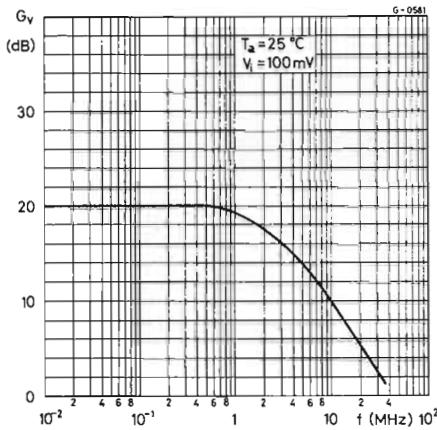



Fig. 8 - Typical FM detector output voltage versus input voltage

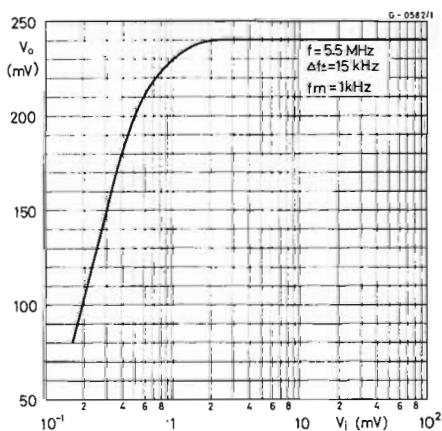



Fig. 9 - Typical amplitude-modulation rejection versus input voltage

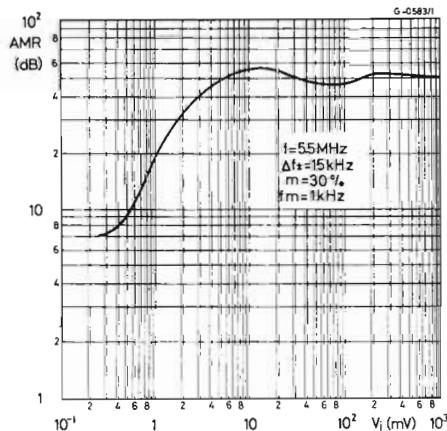



Fig. 10 - Typical gain reduction versus resistance (P2) (terminal 6 to gnd)

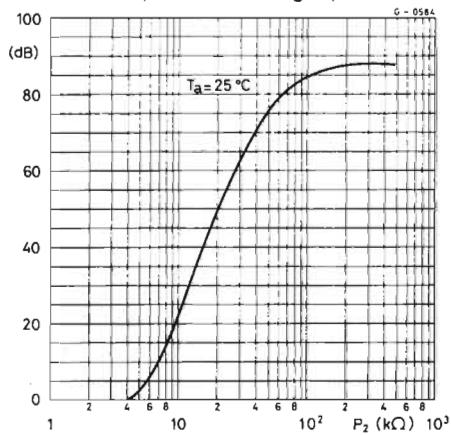
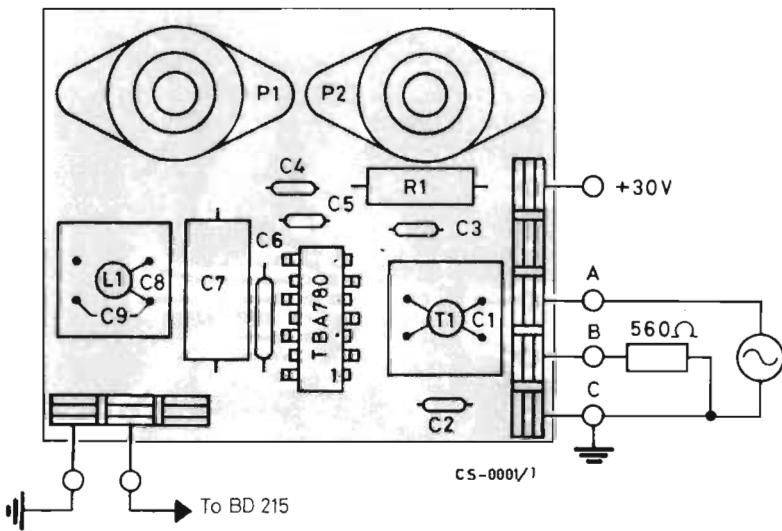



Fig. 11 - P.C. board layout, 1:1 scale (fig. 2 circuit)

LINEAR INTEGRATED CIRCUIT

TBA 800

PRELIMINARY DATA

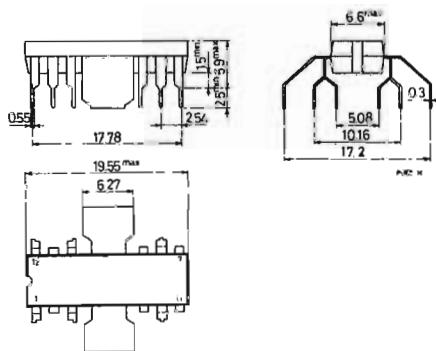
AUDIO POWER AMPLIFIER

The TBA 800 is an integrated monolithic power amplifier in a 12-lead quad in-line plastic package. The external cooling tabs enable 2.5 W output power to be achieved without external heat-sink and 5 W output power using a small area of the P.C. board Copper as a heat sink.
It is intended for use as a low frequency Class B amplifier.
The TBA 800 provides 5 W output power at 24 V/16 Ω and works with a wide range of supply voltages (5-30 V); it gives high output current (up to 1.5 A), high efficiency (70% at 4 W output), very low harmonic distortion and no cross-over distortion.

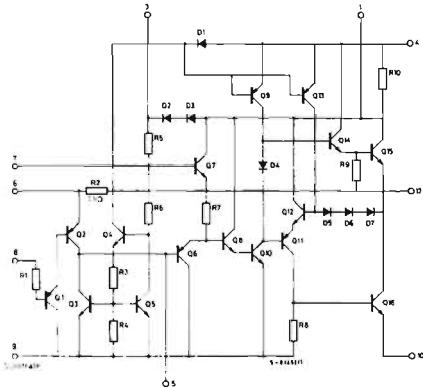
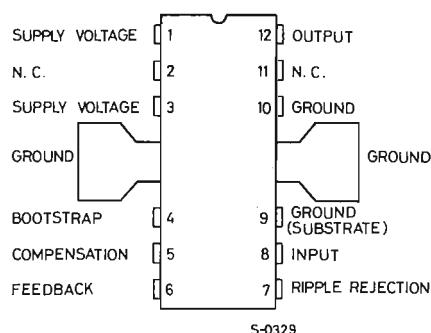
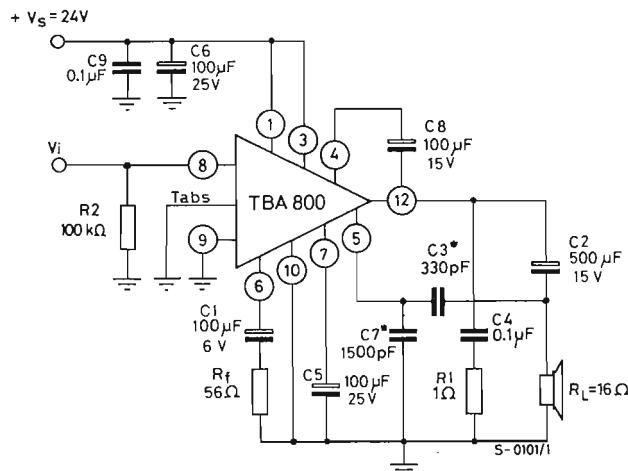
ABSOLUTE MAXIMUM RATINGS

V_s	Supply voltage	30	V
I_o	Output peak current (non repetitive)	2	A
→ I_o	Output current (repetitive)	1.5	A
→ P_{tot}	Power dissipation at T_{amb} = 80 °C	1	W
	at T_{tab} = 90 °C	5	W
→ T_{stg}; T_j	Storage and junction temperature	-40 to 150	°C

MECHANICAL DATA

Dimensions in mm

TBA 800

CONNECTION AND SCHEMATIC DIAGRAM

(top view)

TEST AND APPLICATION CIRCUIT

* C3, C7 see fig. 5

THERMAL DATA

→ $R_{th\ j-tab}$	Thermal resistance junction-tab	max	12	°C/W
→ $R_{th\ j-amb}$	Thermal resistance junction-ambient	max	70*	°C/W

* Obtained with tabs soldered to printed circuit with minimized copper area.

ELECTRICAL CHARACTERISTICS (Refer to the TEST CIRCUIT, T_{amb} = 25 °C)

	Parameter		Test conditions	Min.	Typ.	Max.	Unit
	V_s	Supply voltage		5		30	V
	V_o	Quiescent output voltage (pin 12)	V_s = 24 V	11	12	13	V
→	I_d	Quiescent drain current (pin 12)'	V_s = 24 V		9	20	mA
→	I_b	Bias current (pin 8)	V_s = 24 V		1	5	μA
→	P_o	Output power	d = 10 % V_s = 24 V R_L = 16 Ω f = 1 kHz	4.4	5		W
→	$V_{i\ (rms)}$	Input voltage				220	mV
→	$V_{i\ (rms)}$	Input sensitivity	P_o = 5 W V_s = 24 V R_L = 16 Ω f = 1 kHz		80		mV
→	R_i	Input resistance (pin 8)			5		MΩ
→	B	Frequency response (-3 dB)	V_s = 24 V R_L = 16 Ω C3 = 330 pF		40 to 20000		Hz
	d	Distortion	P_o = 50 mW to 2.5 W V_s = 24 V R_L = 16 Ω f = 1 kHz		0.5		%
→	G_v	Voltage gain (open loop)	V_s = 24 V R_L = 16 Ω f = 1 kHz		80		dB
→	G_v	Voltage gain (closed loop)	V_s = 24 V R_L = 16 Ω f = 1 kHz	39	42	45	dB

TBA 800

ELECTRICAL CHARACTERISTICS (continued)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
→ e_N	Input noise voltage	V_s = 24 V R_g = 0 B(−3 dB) = 40 to 20,000 Hz		5		μV
→ i_N	Input noise current	V_s = 24 V B(−3 dB) = 40 to 20,000 Hz		0.2		nA
η	Efficiency	P_o = 4 W V_s = 24 V R_L = 16 Ω f = 1 kHz		70		%

Fig. 1 - Typical output power versus supply voltage

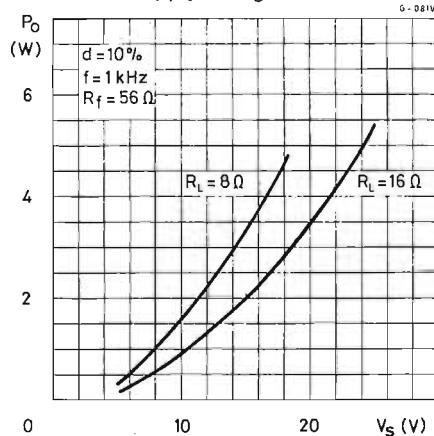



Fig. 2 - Maximum power dissipation versus supply voltage

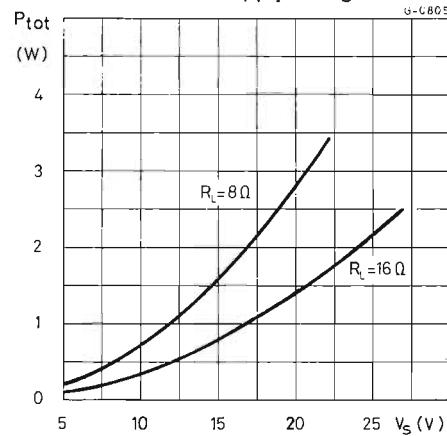



Fig. 3 - Typical distortion versus output power

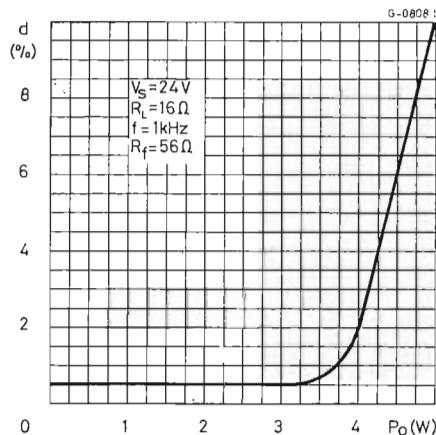



Fig. 4 - Typical distortion versus frequency

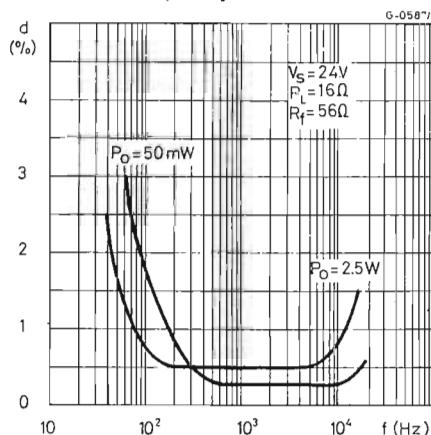



Fig. 5 - Value of C3 versus R_f for various values of B

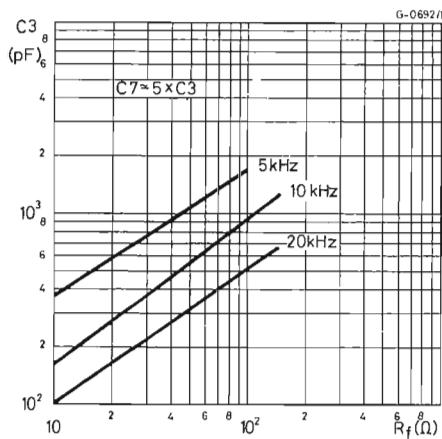



Fig. 6 - Typical voltage gain (closed loop) and typical input voltage versus R_f

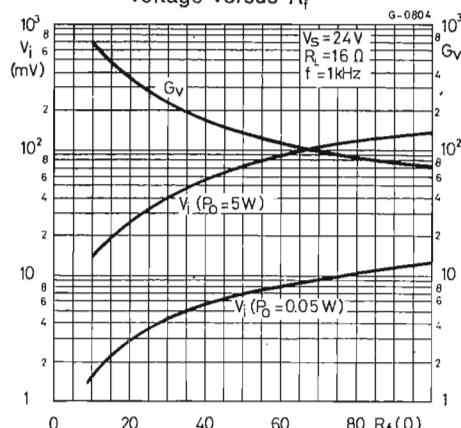



Fig. 7 - Typical power dissipation and efficiency versus output power

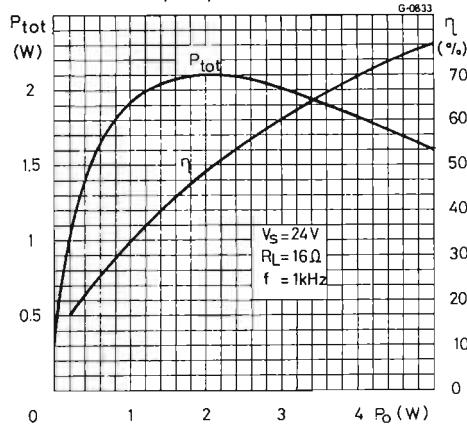



Fig. 8 - Typical quiescent output voltage (pin 12) versus supply voltage

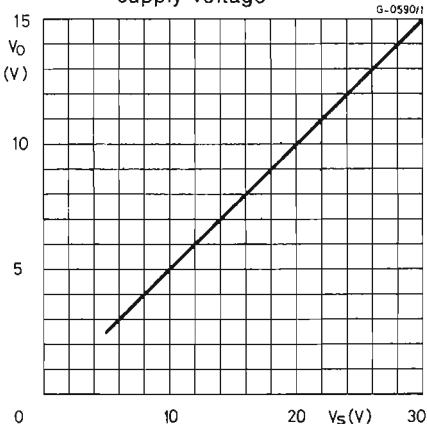



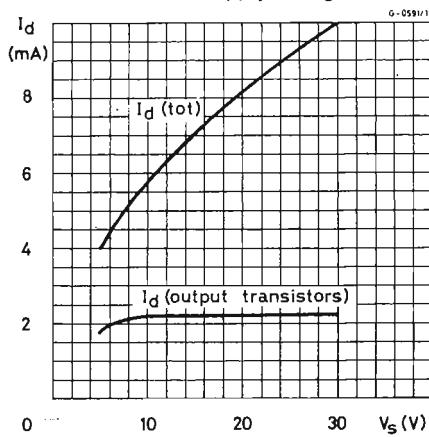
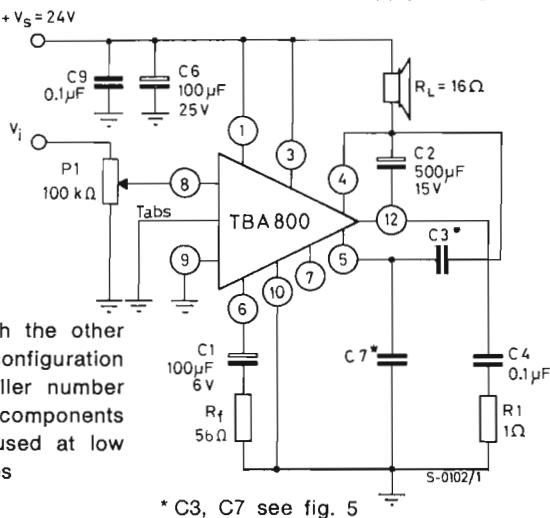
Fig. 9 - Typical quiescent current versus supply voltage

APPLICATION INFORMATION

Fig. 10 - Circuit with the load connected to the supply voltage

Compared with the other circuits, this configuration entails a smaller number of external components and can be used at low supply voltages

* C3, C7 see fig. 5

Fig. 11 - Circuit with load connected to ground without bootstrap

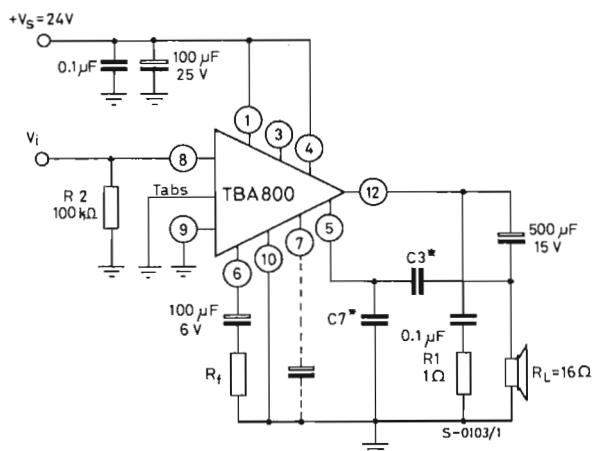
* C3, C7 see fig. 5

There is no bootstrap connection and hence there is a greater loss of potential output swing.
This circuit is only for use at high voltages.
In the absence of "bootstrap", the reduction in the upper part of the wave is greater than that in the lower part: if pin 3 is left open circuit, this automatically inserts diodes D2 - D3 (see schematic diagram) and this enables a symmetrical wave to be obtained at the output.

Fig. 12 - Typical distortion versus output power (fig. 11 circuit)

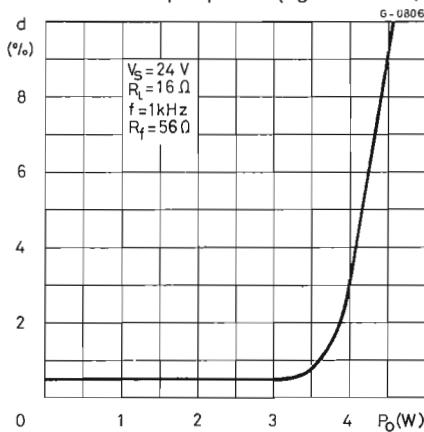



Fig. 13 - Typical output power versus supply voltage (fig. 11 circuit)

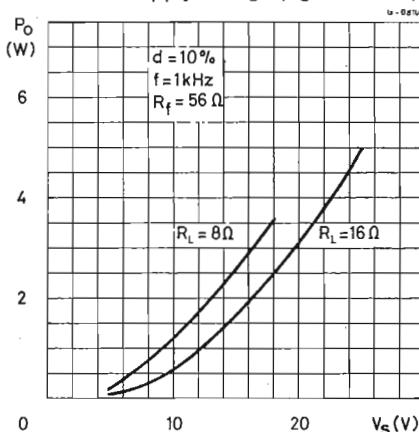
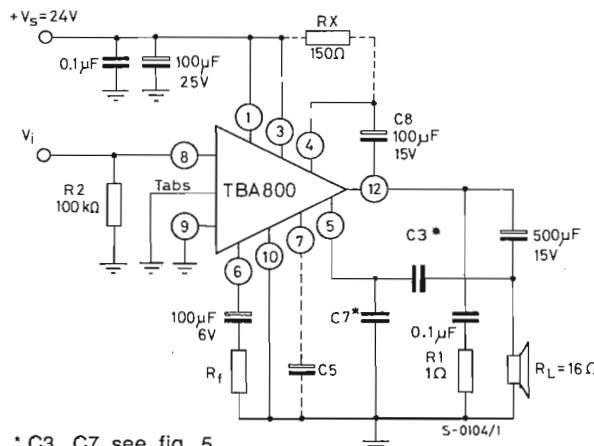



Fig. 14 - Circuit with load connected to ground with bootstrap

* C3, C7 see fig. 5

The bootstrap capacitor C8 enables the same electrical characteristics as circuit of to test circuit to be achieved.
For low supply voltage operation (e.g. 9-14 V), 150 Ω is connected between pin 1 and pin 4

N.B. - For the circuits of figures 11 and 14 an excellent supply voltage ripple rejection is obtained by connecting the capacitor C5 (10 to 100 μF - 25 V) between pin 7 and ground.

MOUNTING INSTRUCTIONS

The tabs on the TBA 800 can be used to conduct away the heat generated in the integrated circuit so that the junction temperature does not exceed the permissible maximum (150 °C).

This may be done by connecting tabs to an external heat sink, or by soldering it to a suitable Copper area of the printed circuit board (fig. 15 a).

Fig. 15 b shows a simple type of heat sink. Assuming an area of copper on the printed circuit board of only 2 cm^2, the total R_{th} between junction to ambient is approximately 30 °C/W.

External heat sink or printed circuit copper area must be connected to electrical ground.

In the latter case, fig. 16 shows the maximum dissipated power (for T_{amb} = 55 °C) as a function of the side of two equal square Copper areas having a thickness of 35 μ (1.4 mils).

Fig. 15 a - Example of an area of P.C. board copper soldered to the tabs of the TBA 800, wich is used as a heat dissipator.

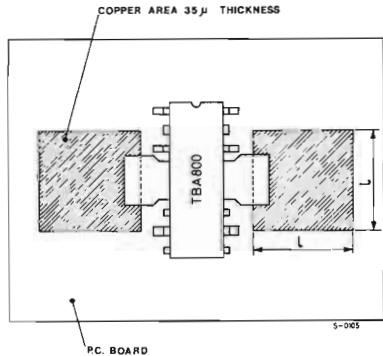



Fig. 15 b - Example of TBA 800 with external heat-sink.

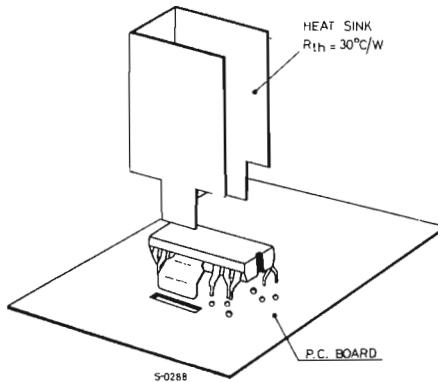



Fig. 16 - Power that can be dissipated versus "l"

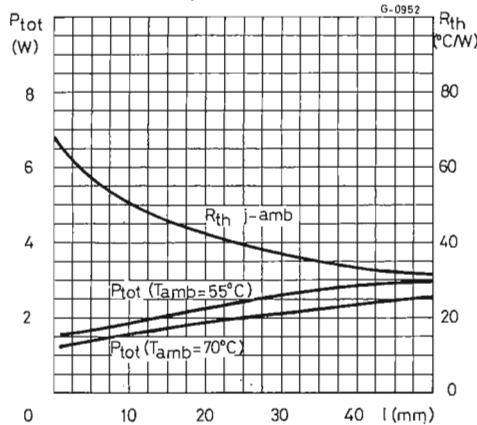



Fig. 17 - Power rating characteristics

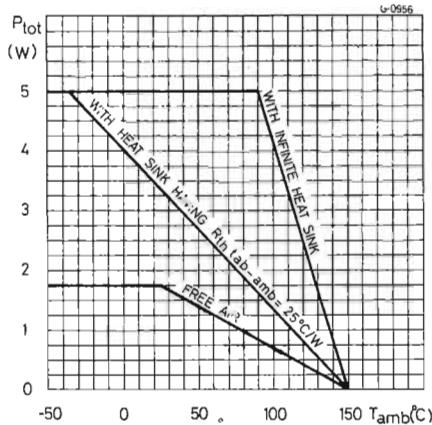



Fig. 18 - P.C. board layout (test circuit).

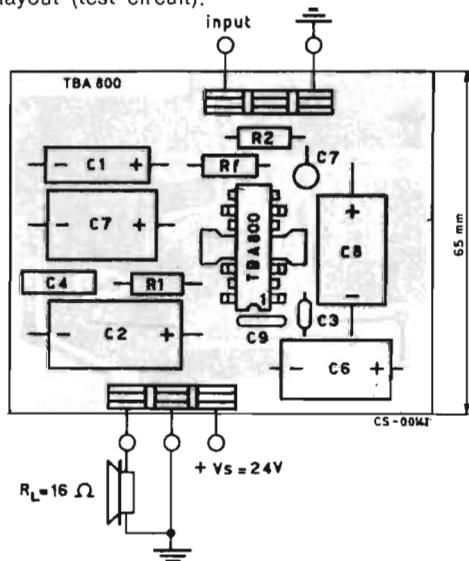
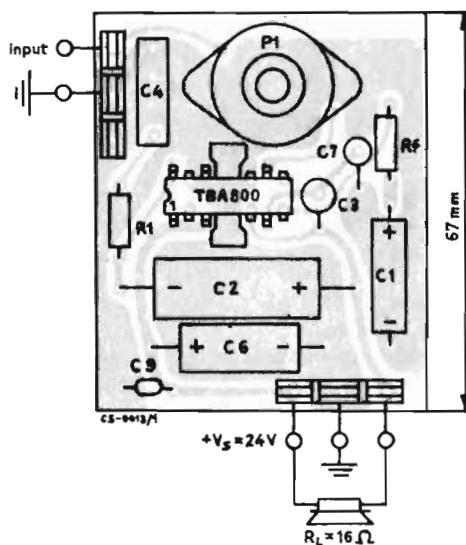



Fig. 19 - P.C. board layout (fig. 10 circuit)

PROCEDURE TO CALCULATE AREA OF COPPER NEEDED

1) Calculate maximum power dissipation

$$P_{tot} = 0.4 \cdot \frac{V_{S\,max}^2}{8\,R_L} + V_{S\,max}\,I_d$$

where

$V_{S\,max}$ = maximum value of supply voltage (increase 10% if not stabilized)

R_L = load resistance

I_d = quiescent drain current for typical value see fig. 10; maximum value at V_S = 24 V is 20 mA (for worst case design)

$T_{amb\,max}$ = 70 °C

PROCEDURE TO CALCULATE AREA OF COPPER NEEDED (continued)

2) Fig. 16 gives ℓ

Examples:

a) V_S (not stabilized) = 24 V; R_L = 16 Ω

$$P_{tot} = 0.4 \cdot \frac{(24 + 2.4)^2}{8 \cdot 16} + (24 + 2.4) \cdot 20 \cdot 10^{-3} = 2.6 \text{ W}$$

From fig. 16 $\ell \cong 25$ mm

For geometries different from the one of fig. 15 note that copper areas near the tabs have better efficiency as regards power dissipation. Therefore additional safety factors must be added for worst case designs

b) V_S (stabilized) = 12 V; R_L = 8 Ω

$$P_{tot} = 0.4 \cdot \frac{12^2}{8 \cdot 8} + 0.02 \cdot 12 = 1 \text{ W}$$

The fig. 16 shows that no heat sink is required if $T_{amb} \leqq 55\,°C$

TBA 810S
TBA 810AS

PRELIMINARY DATA

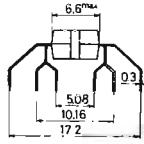
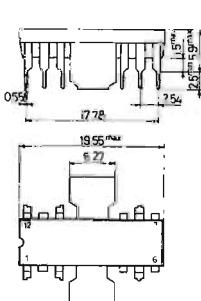
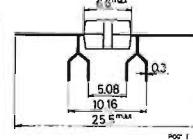
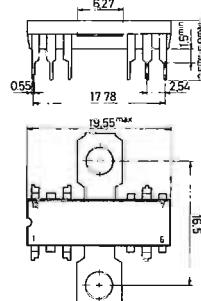
7 W AUDIO POWER AMPLIFIER WITH THERMAL SHUT-DOWN

The TBA 810 S is a monolithic integrated circuit in a 12-lead quad in-line plastic package, intended for use as a low frequency class B amplifier.
The TBA 810 S provides 7 W power output at 16 V/4 Ω, 6 W at 14.4 V/4 Ω, 2.5 W at 9 V/4 Ω, 1 W at 6 V/4 Ω and works with a wide range of supply voltages (4 to 20 V); it gives high output current (up to 2.5 A), high efficiency (75% at 6 W output), very low harmonic and cross-over distortion. In addition, the circuit is provided with a thermal limiting circuit which fundamentally changes the criteria normally used in determining the size of the heat sink.
The TBA 810 AS has the same electrical characteristics as the TBA 810 S, but its cooling tabs are flat and pierced so that an external heat sink can easily be attached.

ABSOLUTE MAXIMUM RATINGS

V_s	Supply voltage	20	V
I_o	Output peak current (non-repetitive)	3.5	A
I_o	Output current (repetitive)	2.5	A
P_{tot}	Power dissipation: at T_{amb} = 70 °C	1	W
	at T_{tab} = 100 °C	5	W
T_{stg}, T_j	Storage and junction temperature	-40 to 150	°C

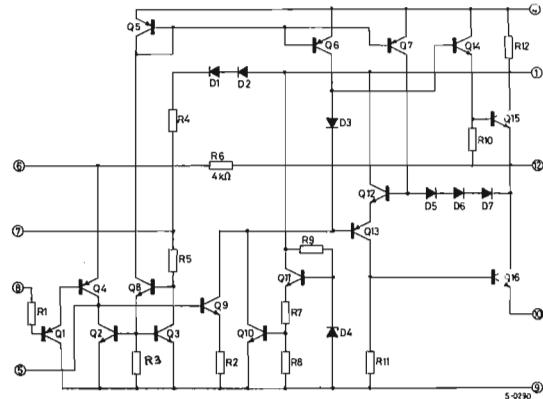
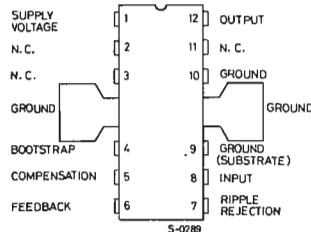
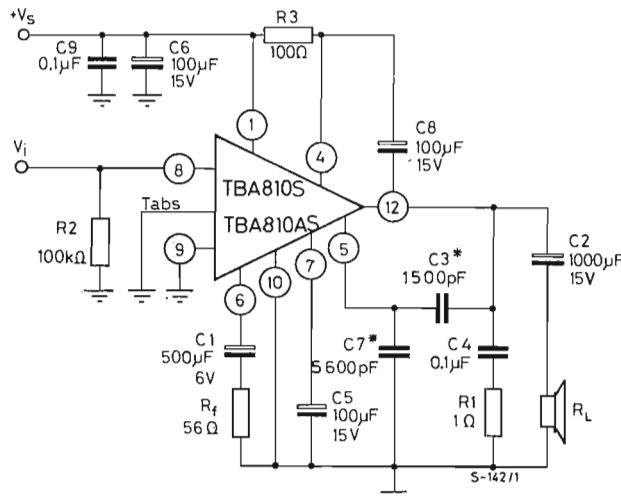
MECHANICAL DATA

Dimensions in mm

TBA 810 S **TBA 810 AS**

TBA 810S
TBA 810AS

CONNECTION AND SCHEMATIC DIAGRAM (top view)

TEST AND APPLICATION CIRCUIT

* C3, C7 see fig. 6.

THERMAL DATA			TBA 810S	TBA 810AS
$R_{th\ j\text{-}tab}$	Thermal resistance junction-tab	max	12 °C/W	10 °C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	70* °C/W	80 °C/W

* Obtained with tabs soldered to printed circuit with minimized copper area.

ELECTRICAL CHARACTERISTICS (Refer to the test circuit; T_{amb} = 25 °C)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
V_s	Supply voltage (pin 1)		4		20	V
V_o	Quiescent output voltage (pin 12)	V_s = 14.4 V	6.4	7.2	8	V
I_d	Quiescent drain current	V_s = 14.4 V		12	20	mA
I_b	Bias current (pin 8)	V_s = 14.4 V		0.4		μA
P_o	Power output	d = 10% R_L = 4 Ω f = 1 kHz V_s = 16 V V_s = 14.4 V V_s = 9 V V_s = 6 V		 7 6 2.5 1		 W W W W
$V_{i(rms)}$	Input voltage				220	mV
V_i	Input sensitivity	P_o = 6 W V_s = 14.4 V R_L = 4 Ω f = 1 kHz R_f = 56 Ω R_f = 22 Ω		 80 35		 mV mV
R_i	Input resistance (pin 8)			5		MΩ
B	Frequency response (-3 dB)	V_s = 14.4 V R_L = 4 Ω C3 = 820 pF C3 = 1500 pF		 40 to 20,000 40 to 10,000		 Hz Hz

ELECTRICAL CHARACTERISTICS (continued)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
d	Distortion	P_o = 50 mW to 3 W V_s = 14.4 V R_L = 4 Ω f = 1 kHz		0.3		%
G_v	Voltage gain (open loop)	V_s = 14.4 V R_L = 4 Ω f = 1 kHz		80		dB
G_v	Voltage gain (closed loop)	V_s = 14.4 V R_L = 4 Ω f = 1 kHz	34	37	40	dB
e_N	Input noise voltage	V_s = 14.4 V R_g = 0 B(-3 dB) = 20 Hz to 20,000 Hz		2		μV
i_N	Input noise current	V_s = 14.4 V B(-3 dB) = 20 Hz to 20,000 Hz		0.1		nA
η	Eficiency	P_o = 5 W V_s = 14.4 V R_L = 4 Ω f = 1 kHz		70		%
SVR	Supply voltage rejection	V_s = 14.4 V R_L = 4 Ω f_{ripple} = 100 Hz		38		dB

Fig. 1 - Typical power output versus supply voltage

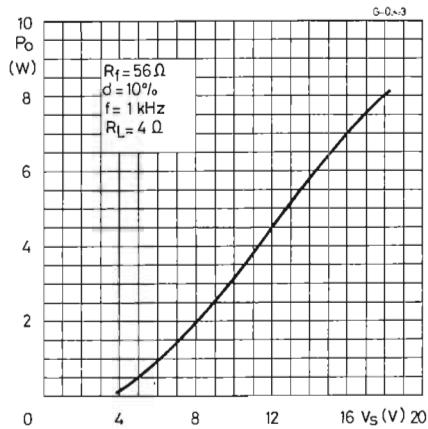



Fig. 2 - Maximum power dissipation versus supply voltage (sine wave operation)

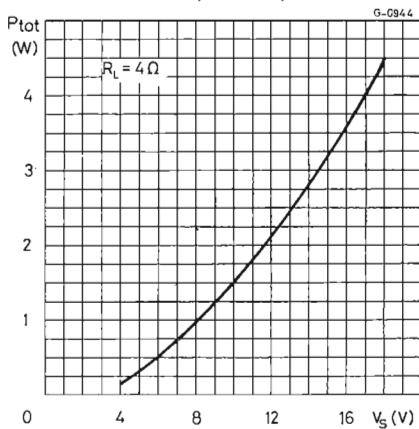



Fig.3 - Typical distortion versus output power

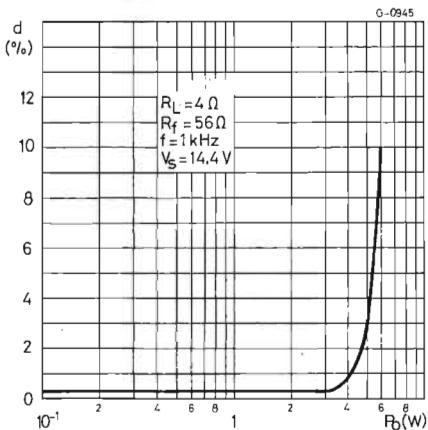



Fig. 4 - Typical distortion versus frequency

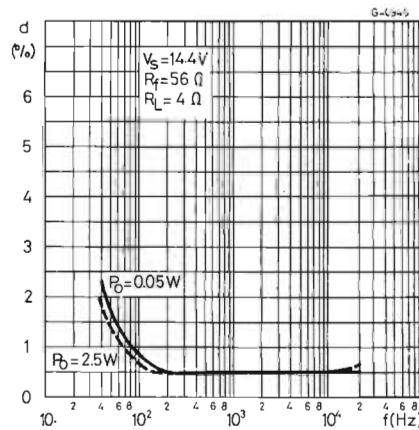



Fig. 5 - Typical relative voltage gain (closed loop) and typical input voltage versus feedback resistance (R_f)

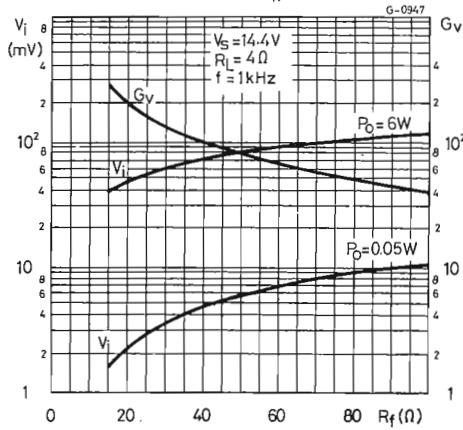



Fig. 6 - Typical value of C3 versus R_f for various values of B

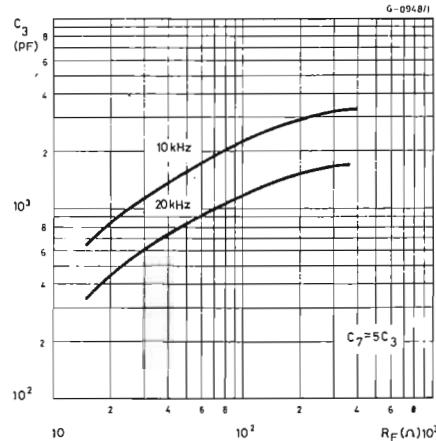



Fig. 7 - Typical power dissipation and efficiency versus output power

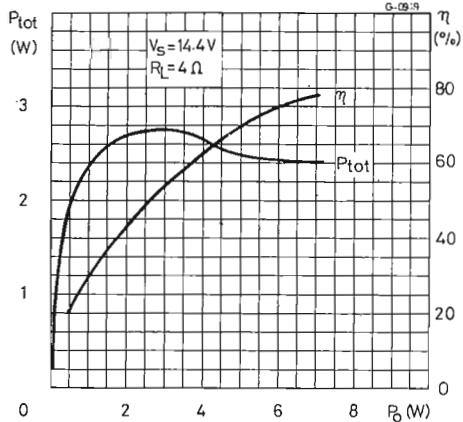



Fig. 8 - Typical quiescent output voltage (pin 12) versus supply voltage

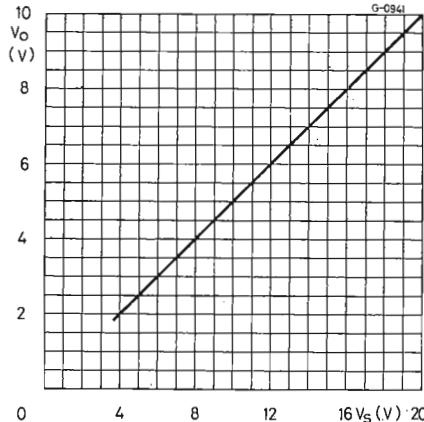



Fig. 9 - Typical quiescent current versus supply voltage

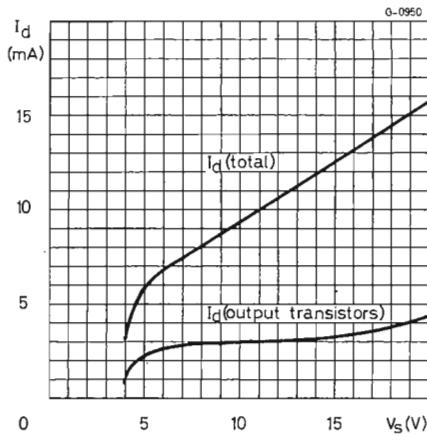



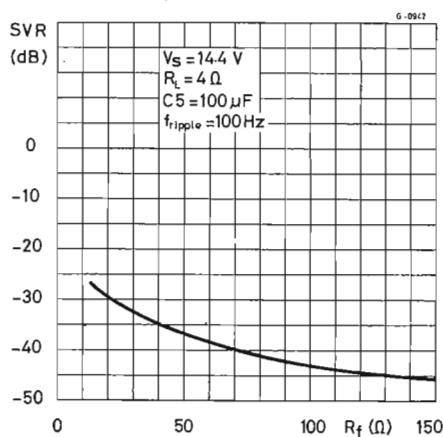
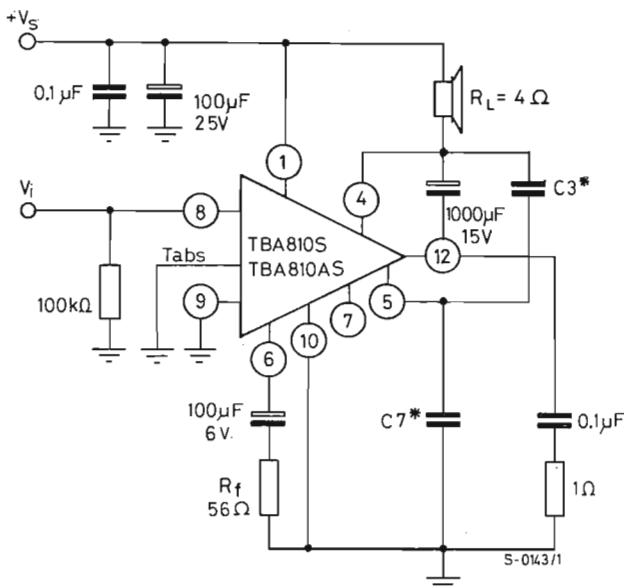
Fig. 10 - Typical supply voltage rejection

For portable equipment the circuit in Fig. 11 has the advantages of fewer external components and a better behaviour at low supply voltages (down to 4 V).

Fig. 11 - Typical circuit with load connected to the supply voltage

* C3, C7 see fig. 6.

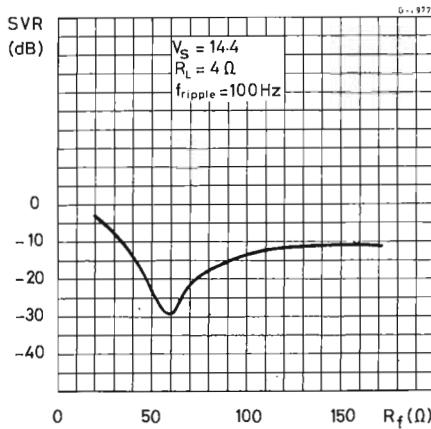



Fig. 12 - Typical supply voltage rejection versus R_f (fig. 11 circuit)

MOUNTING INSTRUCTIONS

The thermal power dissipated in the circuit may be removed by connecting the tabs to an external heat sink (TBA 810 AS - fig. 13) or by soldering them to an area of copper on the printed circuit board (TBA 810 S - fig. 14).
During soldering the tabs temperature must not exceed 260 °C and the soldering time must not be longer than 12 seconds.
Fig. 15a and 15b show two ways that can be used for mounting the device.

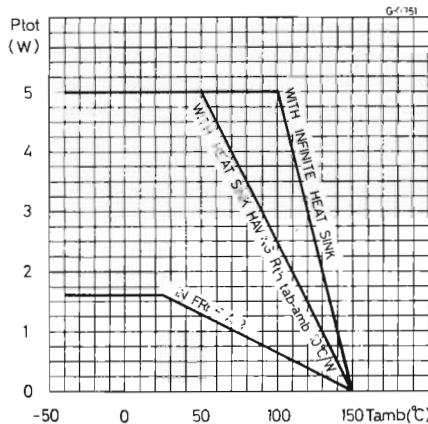



Fig. 13 - Maximum power dissipation versus ambient temperature (for TBA 810 AS only)

Fig. 14 - Maximum power dissipation versus copper area of the P.C. board (for TBA 810 S only)

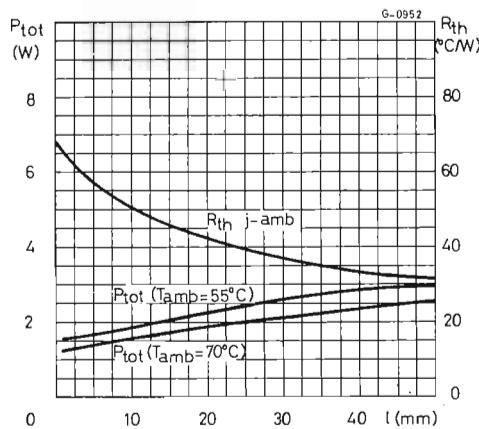
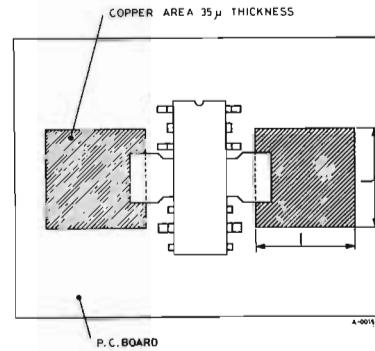



Fig. 15a shows a method, of mounting the TBA 810 S, that is satisfactory both from the point of view of heat dissipation and from mechanical considerations. For TBA 810 AS the desired thermal resistance is obtained by fixing the elements shown in fig. 15b, to a suitably dimensioned plate. This plate can also act as a support for the whole printed circuit board; the mechanical stresses do not damage the integrated circuit. This is firmly fixed to the element, in fig. 15b.

Fig. 15a

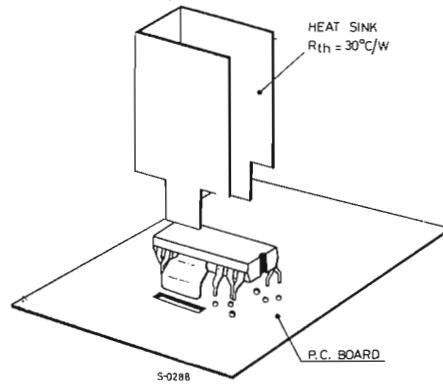
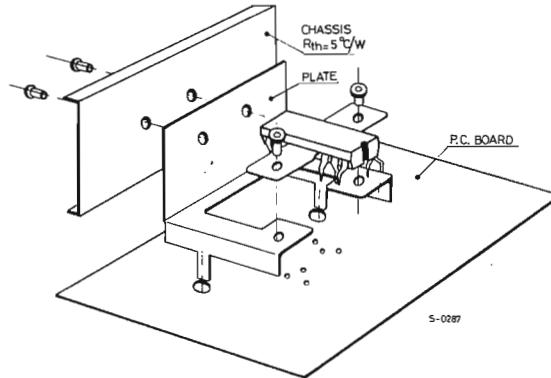
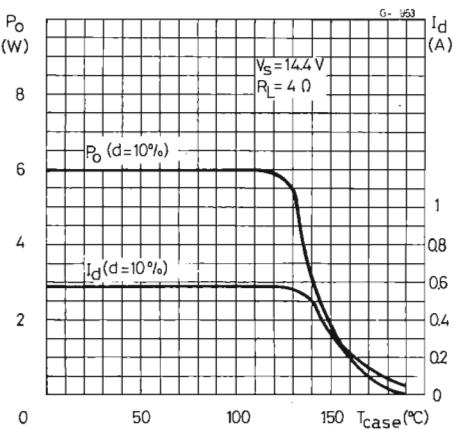



Fig. 15b

THERMAL SHUT-DOWN

The presence of a thermal limiting circuit offers the following advantages:
1) An overload on the output (even if it is permanent), or an above-limit ambient temperature can be easily supported.
2) The heat sink can have a smaller factor of safety compared with that of a conventional circuit. There is no device damage in the case of too high a junction temperature: all that happens is that P_o (and therefor P_{tot}) and I_d are reduced (fig. 16).

Fig. 16 - Output power and drain current versus package temperature

Manufactured under SGS-ATES patents held in several countries, and corresponding to one or more of the following Italian patents: 155139 and others pending.

LINEAR INTEGRATED CIRCUIT

TBA 820

PRELIMINARY DATA

AUDIO AMPLIFIER

The TBA 820 is an integrated monolithic audio amplifier in a 14-lead quad in-line plastic package.
It is intended for use as low frequency class B amplifier with wide range of supply voltage: 3 to 16 V.

Main features are: minimum working voltage of 3 V, low quiescent current, low number of external components, good ripple rejection, no cross-over distortion, mounting compatibility with TAA 611 (see note on last page).

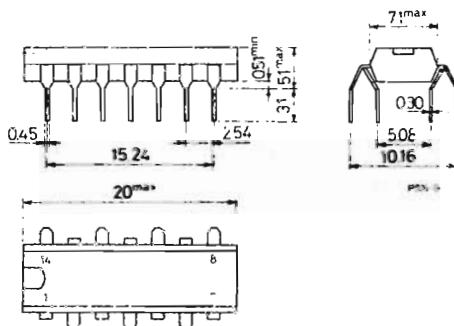
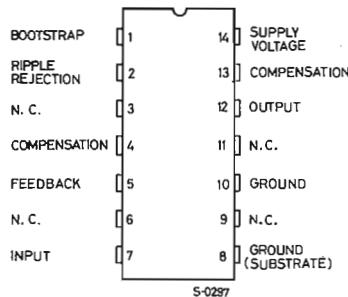
Output power:

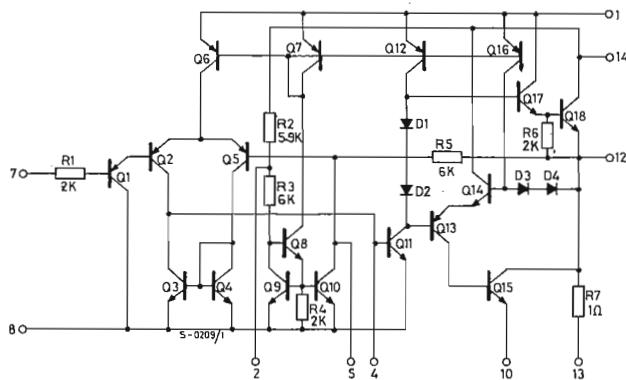
P_o = **2 W** at 12 V - 8Ω • P_o = **1.6 W** at 9 V - 4Ω • P_o = **1.2 W** at 9 V - 8Ω

ABSOLUTE MAXIMUM RATINGS

V_s	Supply voltage	16	V
I_o	Output peak current	1.5	A
P_{tot}	Power dissipation at T_{amb} = 50 °C	1.25	W
T_{stg}; T_j	Storage and junction temperature	-40 to 150	°C

MECHANICAL DATA

Dimensions in mm

CONNECTION DIAGRAM

SCHEMATIC DIAGRAM

TEST AND APPLICATION CIRCUITS

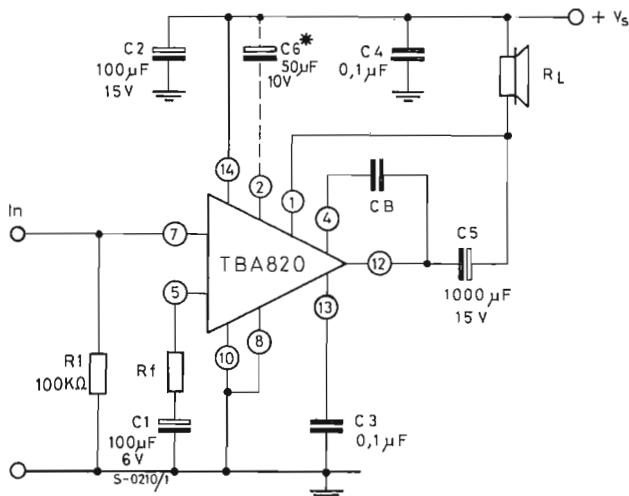



Fig. 1
Circuit diagram with load connected to the supply voltage

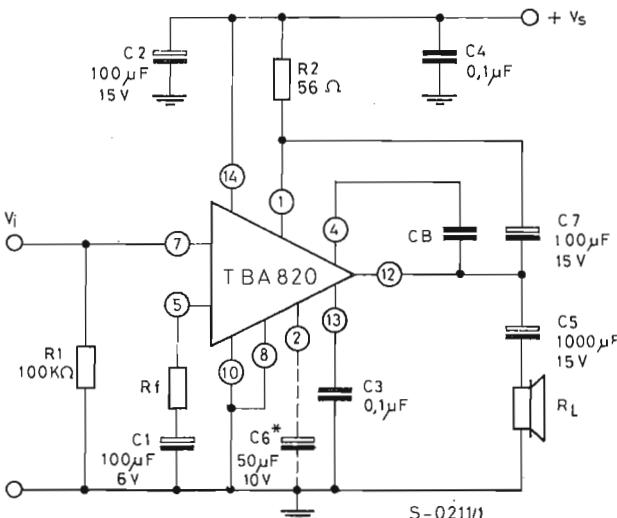



Fig. 2
Circuit diagram with load connected to ground

* Capacitor C6 must be used when high ripple rejection is requested.

TBA 820

THERMAL DATA

$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient (copper frame)	80 °C/W

ELECTRICAL CHARACTERISTICS

(Output powers measured at pin 12, T_{amb} = 25 °C unless otherwise specified)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit	Fig.
V_s	Supply voltage		3		16	V	—
V_o	Quiescent output voltage (pin 12)	V_s = 9 V	4	4.5	5	V	—
I_d	Quiescent drain current	V_s = 9 V		4		mA	—
I_b	Bias current (pin 7)	V_s = 9 V		0.1		μA	—
P_o	Output power	d = 10% f = 1 kHz R_f = 120 Ω V_s = 12 V R_L = 8 Ω V_s = 9 V R_L = 4 Ω V_s = 9 V R_L = 8 Ω V_s = 6 V R_L = 4 Ω V_s = 3.5 V R_L = 4 Ω		 2 1.6 1.2 0.75 0.22		 W W W W W	1
$V_{i\ (rms)}$	Input sensitivity	P_o = 1.2 W V_s = 9 V R_L = 8 Ω f = 1 kHz R_f = 33 Ω R_f = 120 Ω		 16 60		 mV mV	1
$V_{i\ (rms)}$	Input sensitivity	P_o = 50 mW V_s = 9 V R_L = 8 Ω f = 1 kHz R_f = 33 Ω R_f = 120 Ω		 3.5 12		 mV mV	1
R_i	Input resistance			5		MΩ	—
B	Frequency response (-3 dB)	V_s = 9 V R_L = 8 Ω R_f = 120 Ω C_B = 680 pF C_B = 220 pF		 25 to 7000 25 to 20000		 Hz Hz	1
d	Distortion	P_o = 500 mW V_s = 9 V R_L = 8 Ω f = 1 kHz R_f = 33 Ω R_f = 120 Ω		 0.8 0.4		 % %	1

ELECTRICAL CHARACTERISTICS (continued)

	Parameter	Test conditions	Min. Typ. Max.	Unit	Fig.
G_v	Voltage gain (open loop)	V_s = 9 V R_L = 8 Ω f = 1 kHz	75	dB	—
G_v	Voltage gain (closed loop)	V_s = 9 V R_L = 8 Ω f = 1 kHz R_f = 33 Ω R_f = 120 Ω	45 34	dB dB	—
e_N	Input noise voltage	V_s = 9 V B (-3 dB) = = 25 to 20000 Hz	3	μV	—
→ i_N	Input noise current	V_s = 9 V B (-3 dB) = = 25 to 20000 Hz	0.4	nA	—
$\frac{S+N}{N}$	Signal and noise to noise ratio	V_s = 9 V R_L = 8 Ω R_f = 120 Ω B (-3 dB) = = 25 to 20000 Hz R1 = 100 kΩ P_o = 1.2 W	70	dB	—
SVR	Supply voltage rejection	V_s = 9 V R_L = 8 Ω f (ripple) = 100 Hz C6 = 50 μF R_f = 120 Ω	42	dB	2

Fig. 3 - Typical power output

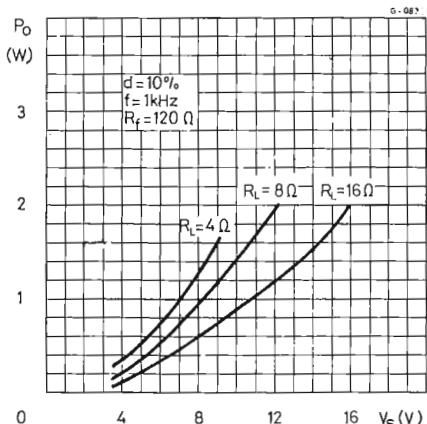



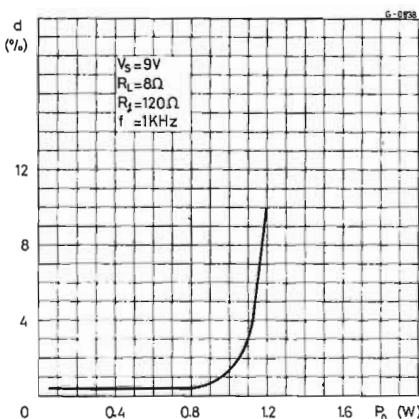
Fig. 4 - Typical distortion

TBA 820

Fig. 5 - Typical power dissipation and efficiency

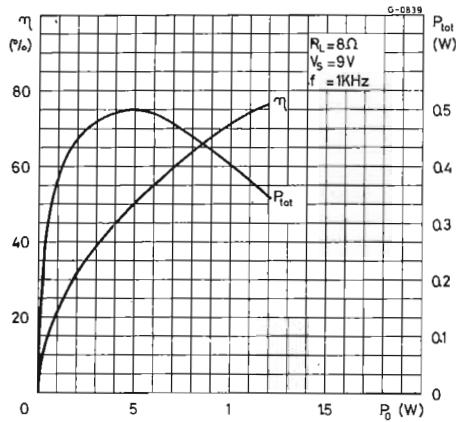



Fig. 6 - Maximum power dissipation (sine wave operation)

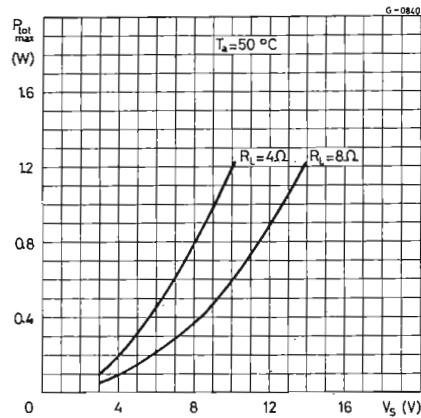



Fig. 7 - Typical value of C_B versus R_f

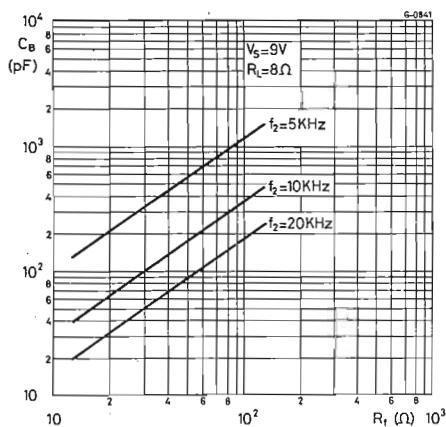



Fig. 8 - Typical relative frequency response

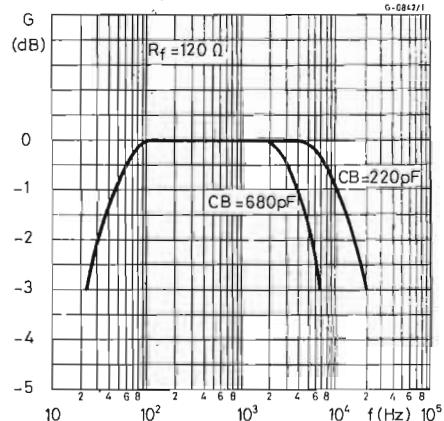



Fig. 9 - Typical input sensitivity

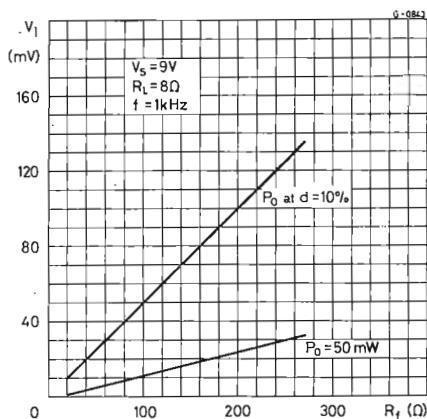



Fig. 10 - Typical voltage gain (closed loop)

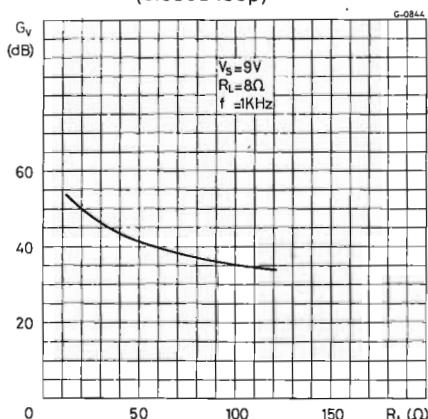



Fig. 11 - Typical distortion

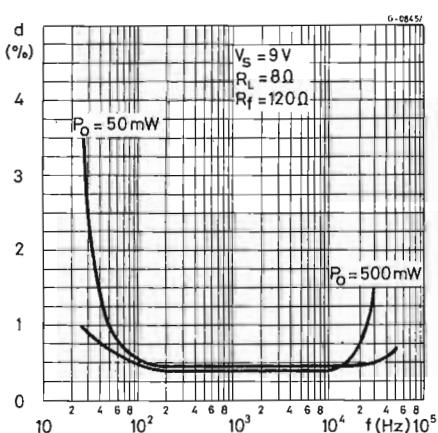



Fig. 12 - Typical supply voltage rejection (fig. 2 circuit)

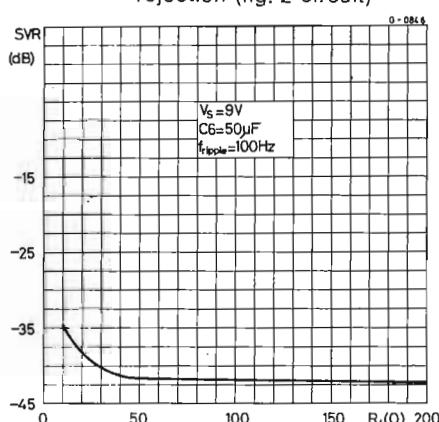



Fig. 13 - Quiescent output voltage at pin 12

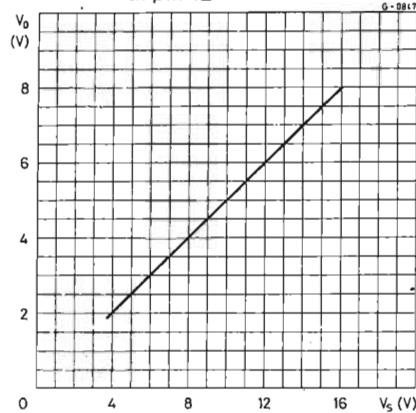



Fig. 14 - Quiescent current

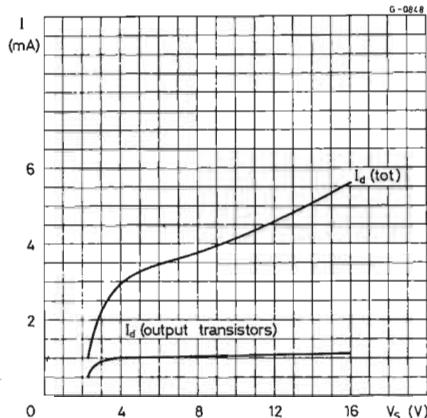
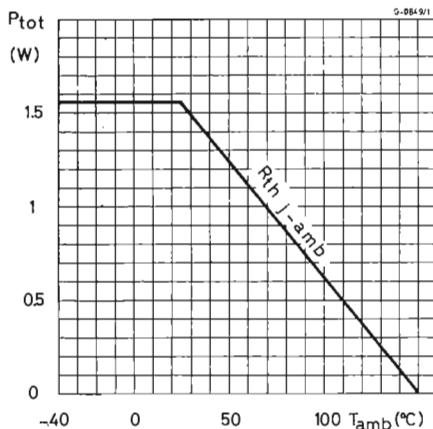



Fig. 15 - Power rating chart

NOTE: Mounting compatibility with TAA 611 provided that P.C. board strips of pins 2 and 13 are disconnected.

TCA 511

LINEAR INTEGRATED CIRCUIT

PRELIMINARY DATA

TV HORIZONTAL AND VERTICAL PROCESSOR

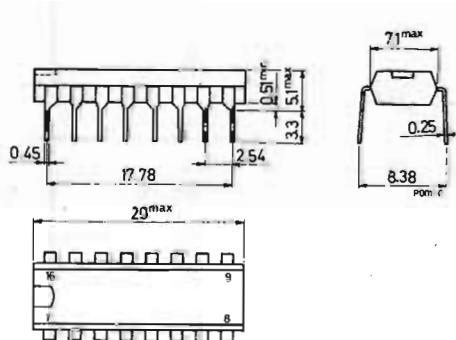
The TCA 511 is a silicon monolithic integrated circuit in a 16-lead dual in-line plastic package. It incorporates the following functions: high stability horizontal oscillator, horizontal APC circuit with high noise immunity and large pull-in range, high stability vertical oscillator and sawtooth generator.
It is intended for driving TV horizontal and vertical transistorized output stages.

ABSOLUTE MAXIMUM RATINGS

V_s	Vertical section supply voltage (between pins 3 and 13)	15	V
V_s	Horizontal section supply voltage (between pins 4 and 13)	15	V
V_7, V_{12}, V_{15}	Pin 7, 12, 15 voltage (collector to ground)	15	V
V_i	Vertical sync. input voltage (between pins 2 and 13 - see note)	-5	V
V_i	Horizontal sync. input voltage (between pins 6 and 13 - see note)	-5	V
I_8	DC current (from pin 8)	30	mA
I_{12}, I_{14}, I_{15}	Peak current (into pins 12, 14 and 15)	50	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 60\,°C$	500	mW
T_{stg}	Storage temperature	-55 to 125	°C
→ T_{op}	Operating temperature	0 to 60	°C

NOTE: The positive input voltage at pin 2 and pin 6 must not be greater than the voltage at pin 3 and pin 4 respectively.

MECHANICAL DATA

Dimensions in mm

TCA 511

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit	Fig.
VERTICAL SECTION							
I_3	Quiescent current	V_s = 12 V f = 50 Hz		4		mA	2
V_3*	Supply voltage		9			V	2
V_1	Peak to peak oscillator sawtooth voltage	V_s = 12 V f = 50 Hz		2.6		V	2
V_2	Peak sync. input voltage	V_s = 12 V f = 50 Hz	3			V	2
V_{14}	Low level output voltage	V_s = 12 V I_{15} = 15 mA			1.5	V	3
V_{15}	Low level output voltage	V_s = 12 V I_{15} = 15 mA			0.5	V	3
R_2	Parallel input resistance at pin 2	V_s = 12 V V_2 = 3 V		50		kΩ	—
t**	Output pulse width at pin 15	V_s = 12 V f = 50 Hz R_{10} = 15 kΩ		0.75		ms	2
Δf	Locking range	V_s = 12 V f = 50 Hz		-17		%	2
$\frac{\Delta f}{\Delta T_{amb}}$	Frequency/temperature coefficient	V_s = 12 V T_{amb} = 20 to 70 °C		-0.015		$\frac{Hz}{°C}$	2
HORIZONTAL SECTION							
I_4	Quiescent current	V_s = 12 V f = 15625 Hz R_{11-13} = 0		19		mA	2
V_4*	Supply voltage		9			V	2
V_6	Peak sinc. input voltage	V_s = 12 V f = 15625 Hz	3			V	2

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min. Typ. Max.	Unit	Fig.
→ V_8	Regulated output voltage	$V_s = 12$ V f = 15625 Hz	7.5	V	2
V_{10}	Peak to peak oscillator sawtooth voltage		3.3	V	
V_{12}	Low level output voltage	$V_s = 12$ V $I_{12} = 15$ mA	0.45	V	3
R_6	Parallel input resistance at pin 6	$V_s = 12$ V $V_6 = 3$ V	50	kΩ	—
t***	Output pulse width at pin 12	$V_s = 12$ V f = 15625 Hz a) $R_{11-13} = 0$ b) $R_{11-13} = \infty$	 13 35	 µs µs	2
t_d	Leading edge of output pulse to leading edge of sync. pulse phasing	$V_s = 12$ V f = 15625 Hz	4	µs	
Δf	Pull-in range		± 1.3	kHz	
Δf	Hold-in range		± 1.4	kHz	
$\frac{\Delta f}{\Delta V_9}$	Oscillator control sensitivity	$V_s = 12$ V	10	$\frac{kHz}{V}$	
$\frac{\Delta f}{\Delta t_d}$	APC loop gain		2	$\frac{kHz}{\mu s}$	
$\frac{\Delta f}{\Delta V_s}$	Oscillator frequency drift	$V_s = 9$ to 14 V	+ 0.7	$\frac{\%}{V}$	
$\frac{\Delta f}{\Delta T_{amb}}$	Frequency/temperature coefficient	$V_s = 12$ V $T_{amb} = 20$ to 70 °C	+ 5	$\frac{Hz}{°C}$	

NOTES: * Minimum supply voltage for correct operation of the device.

** The output pulse width can be adjusted by means of the external resistance connected between pins 1 and 6.

*** The output pulse width can be adjusted by means of the external resistance or by a voltage ≤ 5.3 V, connected between pin 11 and pin 13.

Fig. 1 - Functional block diagram

S-0212

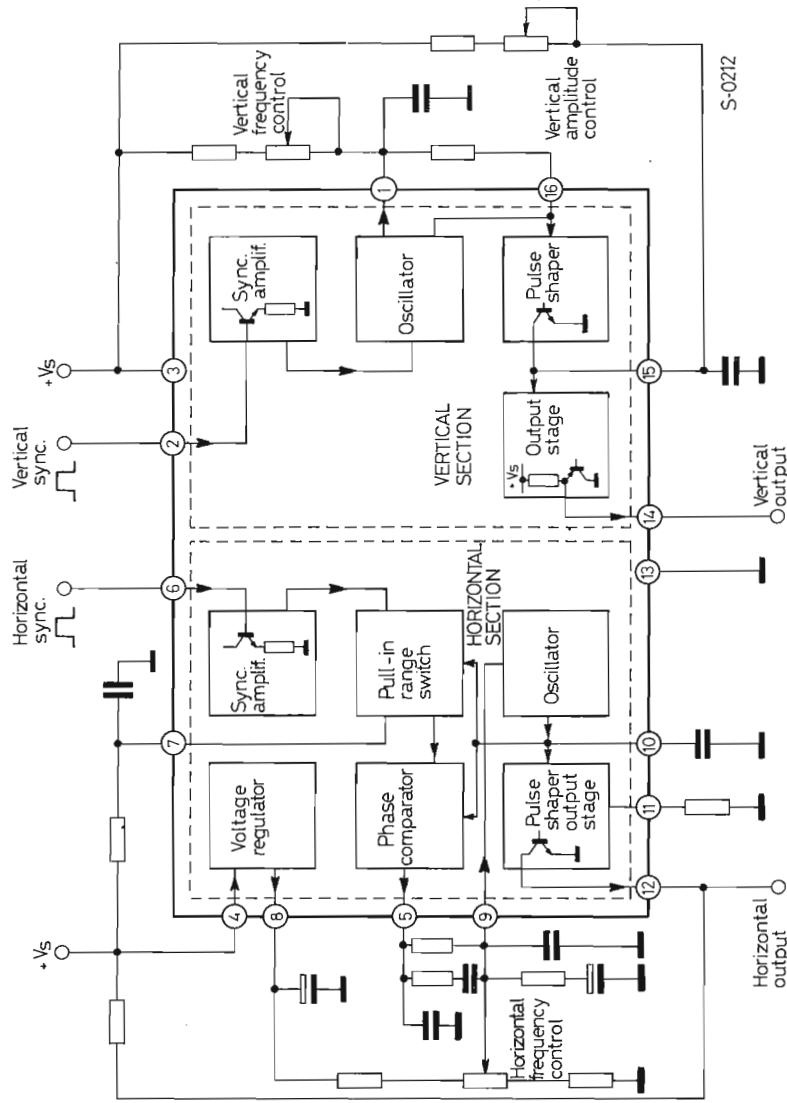
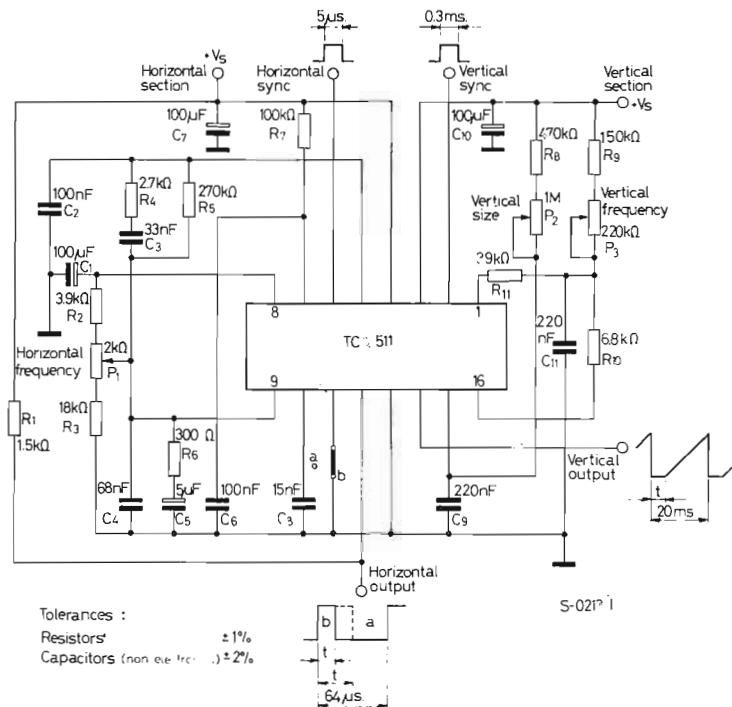



Fig. 2 - Test circuit

Fig. 3 - V_{12}, V_{14} and V_{15} test circuit

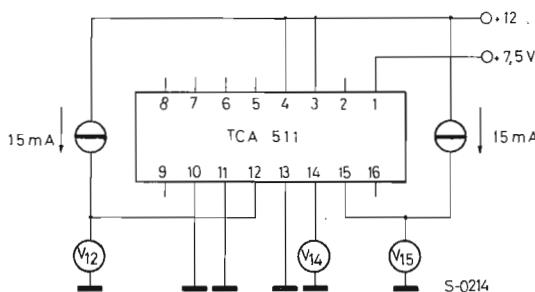
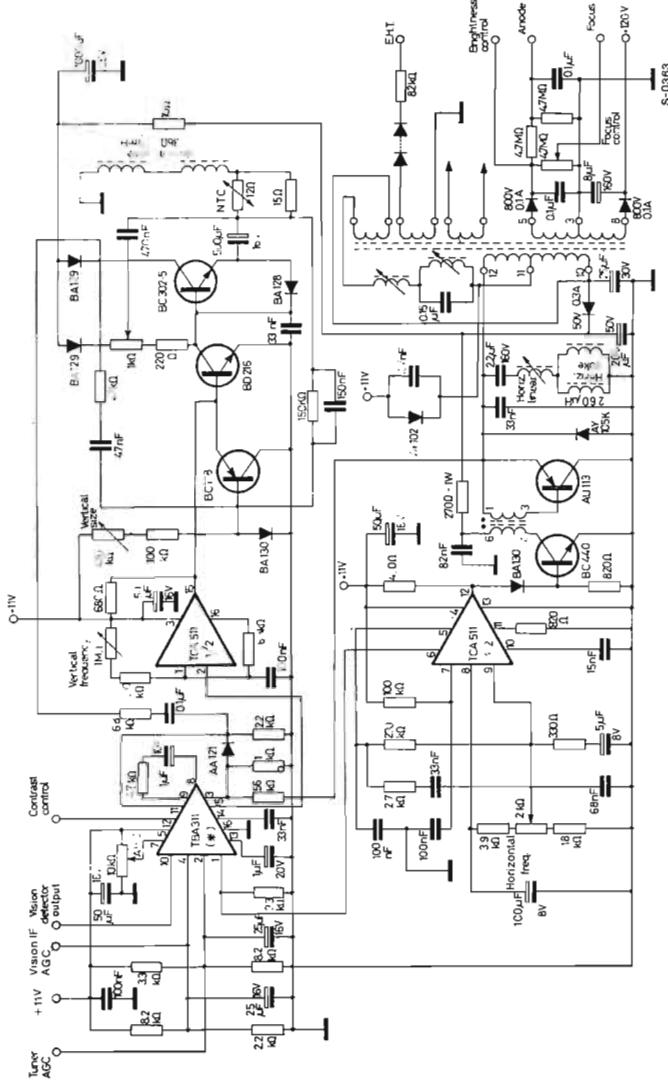



Fig. 4 - Typical application circuit for 12"110° TV set

(*) The jungle circuit TBA 311 performs the following functions:
video preamplifier, IF AGC, PNP and NPN tuner AGC, sync. separator, noise gate.
It is particularly suitable for driving the TCA 511 sync. inputs.

APPLICATION INFORMATION

Power Supply

The circuit can work with stabilized supply voltage having a value from 9 to 15 V. A dropping resistor and a filter capacitor may be used to obtain the supply from higher voltages; however, the voltage on pins 3 and 4 must never exceed the maximum permitted voltage.

Synchronization

Pins 2 and 6 can be DC driven if the reference level of the synchronization pulses is less than 1 V. With reference levels greater than this value, a coupling capacitor must be inserted in series with the input, and pins 2 and 6 must be connected to ground via a resistor.

Vertical Oscillator

The capacitor connected to pin 1 must be selected with regard to the frequency tolerance, to the thermal stabilitv and to the capacitor's ageing.
The width of the output pulse, to be chosen according to the needs of the output stages, is defined by the resistor connected between pin 1 and pin 16.

Vertical Output

The vertical output is taken from pin 14, which is a buffered output of the sawtooth voltage generated at pin 15.
The output current from pin 14 is defined by an internal resistor in the integrated circuit. If a greater current is needed, a resistor may be connected between pin 14 and pin 3.
The oscillator output pulse is available at pin 15 if the capacitor C9 is not connected. This configuration is used for driving output stages in which the sawtooth is generated by Miller effect.

Horizontal Oscillator

The capacitor connected between pin 10 and ground must be selected with regard to the frequency tolerance, to the thermal stability and to the capacitor's ageing.
In multistandard receivers, the oscillation frequency may be changed by switching the value of the capacitor connected to pin 10.

APPLICATION INFORMATION (continued)

Phase Comparator

The phase comparator's output consists of current pulses acting on the oscillator control voltage.
The external components C2, C3, C4, C5, R4, R5 and R6 (fig. 2) define the circuit performance with respect to the pull-in range, the hold-in range and the frequency variations that occur on switching-on and switching-off.
Moreover the pull-in range depends on the absolute value of the voltage divider R2, P1 and R3.
A coincidence detector is connected to pin 7; this modifies the pull-in range and the noise immunity, depending on whether the system is synchronised or is searching for synchronization. The time constant applied to pin 7 avoids uncertainty during the switch from one state to the other.

Horizontal Output

The collector of the output transistor is connected to pin 12; its load resistor, externally connected between pin 12 and pin 4, defines the amplitude of the output current pulse.
The width of the output pulse can be varied between 13 and 35 μs by means of the resistor connected between pin 11 and ground, or else by means of a voltage $\leq$ 5.3 V applied between pin 11 and ground. This control acts upon the trailing edge of the pulse, hence the phase advance of the leading edge stays constant with respect to the synchronism.

LINEAR INTEGRATED CIRCUITS

TCA 600
TCA 610

PRELIMINARY DATA

MOTOR SPEED REGULATORS

The TCA 600 and TCA 610 are integrated circuits in Jedec TO-39 metal case. They are designed for use as speed regulators for DC motors of record players, tape recorders and cassettes.
The TCA 600 is particularly suitable for battery operated portable equipments, and the TCA 610 for car-battery and mains operations.

ABSOLUTE MAXIMUM RATINGS

		TCA 600	TCA 610
V_s	Supply voltage	14 V	20 V
P_{tot}	Total power dissipation at $T_{amb} = 55\ °C$	0.55 W	
	at $T_{case} = 75\ °C$	3 W	
T_{stg}	Storage temperature	-55 to 150 °C	
T_j	Junction temperature	150 °C	

MECHANICAL DATA

Dimensions in mm

TO-39

TCA 600
TCA 610

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	Typ.	25	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	Typ.	175	°C/W

ELECTRICAL CHARACTERISTICS

(T_{amb} = 25 °C and $R_s = \infty$ unless otherwise indicated)

Parameter		Test conditions	Min.	Typ.	Max.	Unit	Fig.
→ V_{ref}	Reference voltage (between pins 2 and 3)	V_s = 5.5 V I_m = 70 mA R_T = 0		2.6		V	1
→ I_{d3}	Quiescent current (at pin 3)	V_{1-3} = 5.5 V I_2 = 0 R_T = 0		2.6		mA	—
→ V_m	Output voltage (for **TCA 600** only)	V_s = 5.5 V I_m = 70 mA R_T = 91 Ω		3.6	3.9	V	1
→ V_m	Output voltage (for **TCA 610** only)	V_s = 9 V I_m = 70 mA R_T = 270 Ω		5.6		V	1
V_{1-2}	Dropout voltage	$\Delta V_m/V_m$ = -1% I_m = 70 mA R_T = 91 Ω		1.2		V	1
→ I_2	Limiting output current (at pin 2)	V_{1-3} = 5.5 V V_{2-3} = 0		400		mA	—
→ $k = \Delta I_2/\Delta I_3$		V_s = 5.5 V I_2 = -70 mA ΔI_2 = ±10 mA R_T = 0		8.5		—	1
$\frac{\Delta V_m}{V_m}/\Delta V_s$	Line regulation (for **TCA 600** only)	V_s = 5.5 V to 12 V I_m = 70 mA R_T = 91 Ω		0.1		%/V	1

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit	Fig.
$\frac{\Delta V_m}{V_m}/\Delta V_s$ Line regulation (for **TCA 610** only)	V_s = 10 V to 16 V I_m = 70 mA R_T = 270 Ω		0.1		%/V	1
$\frac{\Delta V_m}{V_m}/\Delta I_m$ Load regulation	V_s = 5.5 V I_m = 40 to 100 mA R_T = 0		0.005		%/mA	1
$\frac{\Delta V_{ref}}{V_{ref}}/\Delta T_{amb}$ Temperature coefficient	V_{1-3} = 5.5 V I_2 = -70 mA T_{amb} = -20 to 70 °C		0.01		%/°C	—

Fig. 1 - Test circuit.

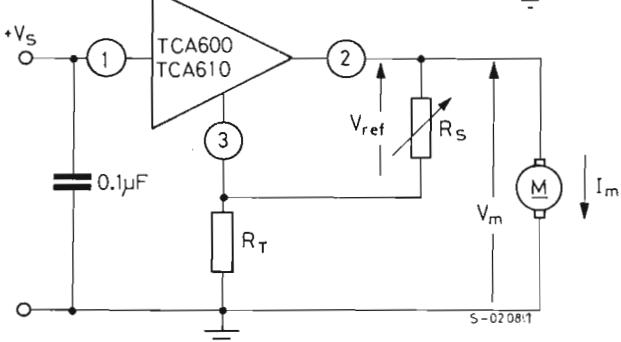
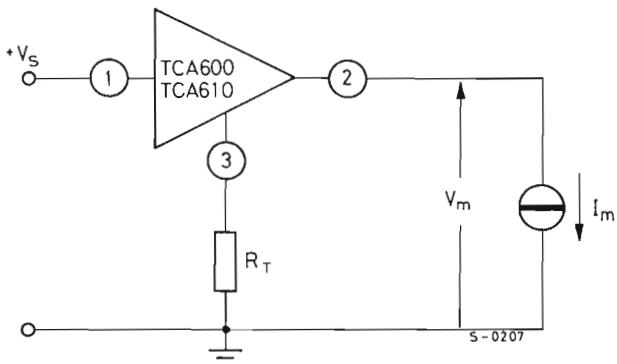



Fig. 2 - Typical application circuit.

TCA 600
TCA 610

Fig. 3 - Normalized k versus I_2.

Fig. 4 - Dropout voltage versus output current.

Fig. 5 - Maximum allowable power dissipation versus ambient temperature.

APPLICATION INFORMATION

The regulator supplies the motor in such a way as to keep its speed constant. independent of supply voltage, applied torque and ambient temperature variations. The basic equation for the motor is:

$$V_m = E_0 + R_m I_m = a_1 n + a_2 c$$

Where: V_m = supply voltage applied to the motor

E_0 = back electromotive force

n = motor speed (r.p.m)

R_m = internal resistance (of the motor)

I_m = current absorbed (by the motor)

a_1 and a_2 = constants

c = drive torque

A voltage supply with the following characteristics

$E = E_0$ E = electromotive force

$R_o = -R_m$ R_o = output resistance

gives performance required.

This means that a variation in current absorbed by the motor, due to a variation in torque applied, causes a proportional variation in regulator output voltage.

In fig. 6 is shown the minimum allowable E_0 versus R_T.

Fig. 6 - Minimum E_0 allowable versus R_T.

The TCA 600 and TCA 610 give a reference constant voltage V_{ref} (between pins 2 and 3) independent of variations of V_s, I_2 and ambient temperature.

They also give:

$$I_3 = I_{d3} + I_2/k$$

Where:
- I_3 = total current at pin 3
- I_{d3} = quiescent current at pin 3 ($I_2 = 0$)
- I_2 = current at pin 2
- k = constant.

The output voltage V_m, applied to the motor has the following value:

$$V_m = \underbrace{V_{ref} + R_T \left[\frac{V_{ref}}{R_s} \left(1 + \frac{1}{k} \right) + I_{d3} \right]}_{\text{Term 1}} + \underbrace{\frac{I_m}{k} R_T}_{\text{Term 2}}$$

Term 1 equals E_0 and fixes the motor speed by means of the variable resistor R_s;
Term 2 $\frac{I_m}{k} \cdot R_T$ equals the term $R_m \cdot I_m$ and, therefore, compensates variations of torque applied.

Complete compensation is achieved when:

$$R_T = k\, R_m$$

If $R_{T\,max} > k\, R_{m\,min}$ instability may occur.

Manufactured under SGS-ATES patents pending in several countries.

LINEAR INTEGRATED CIRCUITS

TCA 900
TCA 910

PRELIMINARY DATA

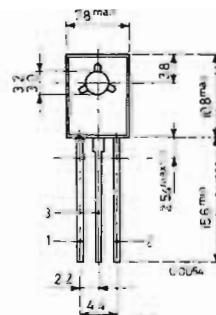
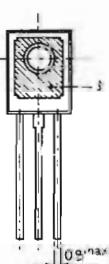
MOTOR SPEED REGULATORS

The TCA 900 and TCA 910 are linear integrated circuits in Jedec TO-126 plastic package. They are designed for use as speed regulators for DC motors of record players, tape recorders and cassettes.
The TCA 900 is particularly suitable for battery operated portable equipments, and the TCA 910 for car-battery and mains operations.

ABSOLUTE MAXIMUM RATINGS

		TCA 900	TCA 910
V_s	Supply voltage	14 V	20 V
P_{tot}	Total power dissipation at T_{amb} = 70 °C	0.8 W	
	at T_{case} = 100 °C	5 W	
T_{stg}	Storage temperature	-55 to 150 °C	
T_j	Junction temperature	150 °C	

MECHANICAL DATA

Dimensions in mm

TCA 900
TCA 910

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	Typ.	10	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	Typ.	100	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C and $R_S = \infty$ unless otherwise specified)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit	Fig.
→ V_{ref}	Reference voltage (between pins 2 and 3)	V_s = 5.5 V I_m = 70 mA R_T = 0		2.6		V	1
→ I_{d3}	Quiescent current (at pin 3)	V_{1-3} = 5.5 V I_2 = 0 R_T = 0		2.6		mA	—
→ V_m	Output voltage (for **TCA 900** only)	V_s = 5.5 V I_m = 70 mA R_T = 91 Ω		3.6	3.9	V	1
V_m	Output voltage (for **TCA 910** only)	V_s = 9 V I_m = 70 mA R_T = 270 Ω		5.6	6.3	V	1
V_{1-2}	Dropout voltage	$\Delta V_m/V_m$ = -1% I_m = 70 mA R_T = 91 Ω		1.2		V	1
I_2	Limiting output current (at pin 2)	V_{1-3} = 5.5 V V_{2-3} = 0		400		mA	—
$k = \Delta I_2/\Delta I_3$		V_s = 5.5 V I_2 = -70 mA ΔI_2 = ±10 mA R_T = 0		8.5		—	1
$\frac{\Delta V_m}{V_m}/\Delta V_s$	Line regulation (for **TCA 900** only)	V_s = 5.5 V to 12 V I_m = 70 mA R_T = 91 Ω		0.1		%/V	1

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min. Typ. Max.	Unit	Fig.
$\frac{\Delta V_m}{V_m}/\Delta V_s$	Line regulation (for **TCA 910** only)	V_s = 10 V to 16 V I_m = 70 mA R_T = 270 Ω	0.1	%/V	1
$\frac{\Delta V_m}{V_m}/\Delta I_m$	Load regulation	V_s = 5.5 V I_m = 40 to 100 mA R_T = 0	0.005	%/mA	1
$\frac{\Delta V_{ref}}{V_{ref}}/\Delta T_{amb}$	Temperature coefficient	V_{1-3} = 5.5 V I_2 = -70 mA T_{amb} = -20 to 70 °C	0.01	%/°C	—

Fig. 1 - Test circuit.

Fig. 2 - Typical application circuit.

Fig. 3 - Normalized k versus I_2.

Fig. 4 - Dropout voltage versus output current.

Fig. 5 - Maximum allowable power dissipation versus ambient temperature.

APPLICATION INFORMATION

The regulator supplies the motor in such a way as to keep its speed constant, independent of supply voltage, applied torque and ambient temperature variations. The basic equation for the motor is:

$$V_m = E_0 + R_m I_m = a_1 n + a_2 c$$

Where: V_m = supply voltage applied to the motor

E_0 = back electromotive force

n = motor speed (r.p.m)

R_m = internal resistance (of the motor)

I_m = current absorbed (by the motor)

a_1 and a_2 = constants

c = drive torque

A voltage supply with the following characteristics

$E = E_0$ E = electromotive force

$R_o = -R_m$ R_o = output resistance

gives performance required.

This means that a variation in current absorbed by the motor, due to a variation in torque applied, causes a proportional variation in regulator output voltage.

In fig. 6 is shown the minimum allowable E_0 versus R_T.

Fig. 6 - Minimum E_0 allowable versus R_T.

The TCA 900 and TCA 910 give a reference constant voltage V_{ref} (between pins 2 and 3) independent of variations of V_s, I_2 and ambient temperature.

They also give:

$$I_3 = I_{d3} + I_2/k$$

Where: I_3 = total current at pin 3
I_{d3} = quiescent current at pin 3 ($I_2 = 0$)
I_2 = current at pin 2
k = constant.

The output voltage V_m, applied to the motor has the following value:

$$V_m = \underbrace{V_{ref} + R_T \left[\frac{V_{ref}}{R_s} \left(1 + \frac{1}{k} \right) + I_{d3} \right]}_{\text{Term 1}} + \underbrace{\frac{I_m}{k} R_T}_{\text{Term 2}}$$

Term 1 equals E_0 and fixes the motor speed by means of the variable resistor R_s;
Term 2 $\frac{I_m}{k} \cdot R_T$ equals the term $R_m \cdot I_m$ and, therefore, compensates variations of torque applied.

Complete compensation is achieved when:

$$R_T = k\ R_m$$

If $R_{T\,max} > k\ R_{m\,min}$ instability may occur.

Manufactured under SGS-ATES patents pending in several countries.

LINEAR INTEGRATED CIRCUIT

TDA 1200

PRELIMINARY DATA

FM-IF RADIO SYSTEM

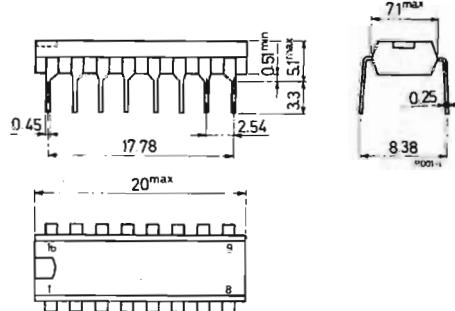
- HIGH LIMITING SENSITIVITY
- HIGH AMR
- HIGH RECOVERED AUDIO
- GOOD CAPTURE RATIO
- LOW DISTORTION
- MUTING CAPABILITY

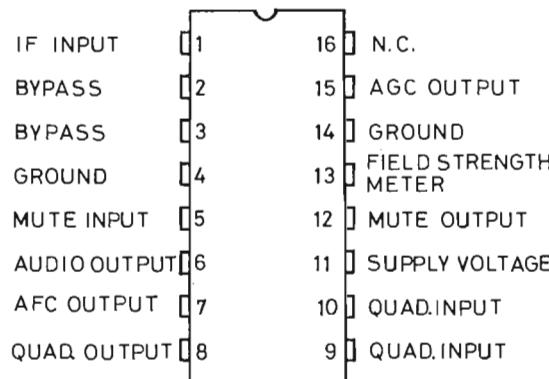
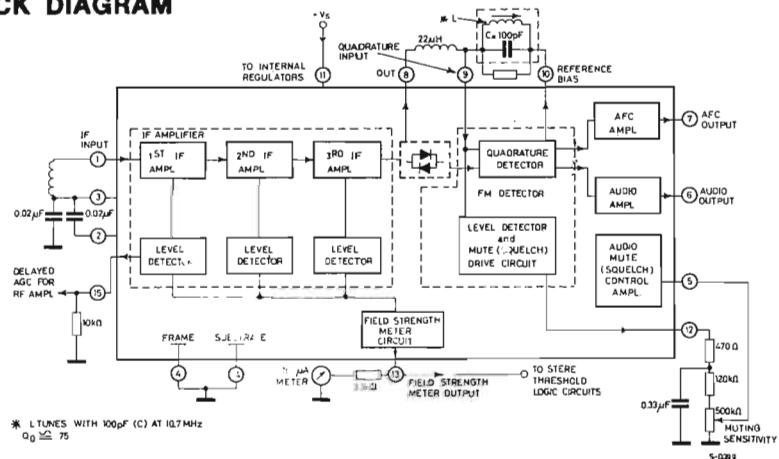
The TDA 1200 is a silicon monolithic integrated circuit in a 16-lead dual in-line plastic package. It provides a complete subsystem for amplification of FM signals.
The functions incorporated are:
— FM amplification and detection
— interchannel controlled muting
— AFC and delayed AGC for FM tuner
— switching of stereo decoder
— driving of a field strength meter
The TDA 1200 can be used for FM-IF amplifier application in HI-FI, car-radios and communication receivers.

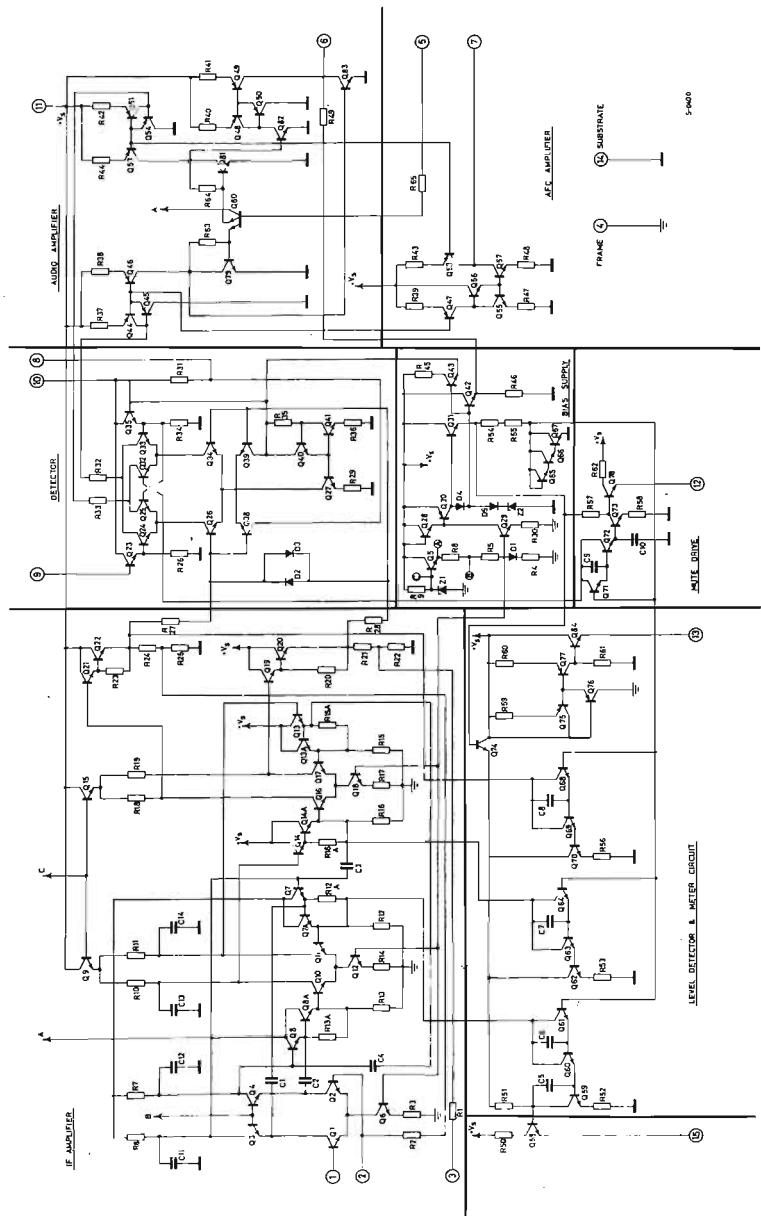
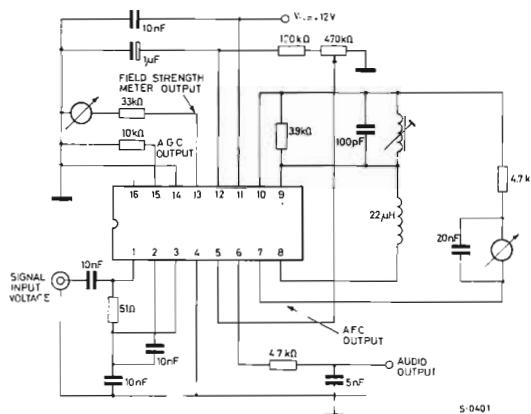
ABSOLUTE MAXIMUM RATINGS

V_s	Supply voltage	16	V
I_o	Output current (from pin 15)	2	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 70\,°C$	500	mW
T_{stg}	Storage temperature	-55 to 150	°C
T_{op}	Operating temperature	-25 to 70	°C

MECHANICAL DATA

Dimensions in mm

TDA 1200

CONNECTION DIAGRAM
(top view)

BLOCK DIAGRAM

SCHEMATIC DIAGRAM

TEST CIRCUIT

THERMAL DATA

$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	Typ.	160	°C/W

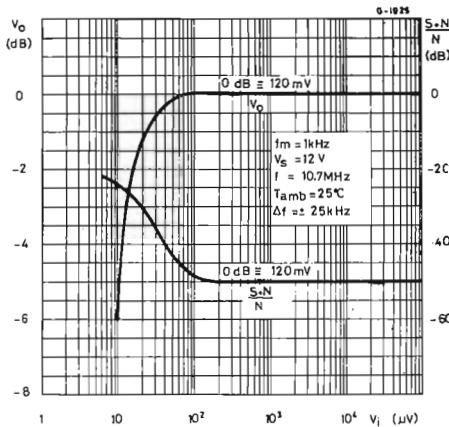
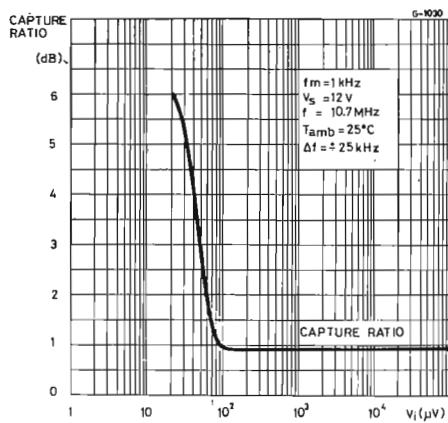
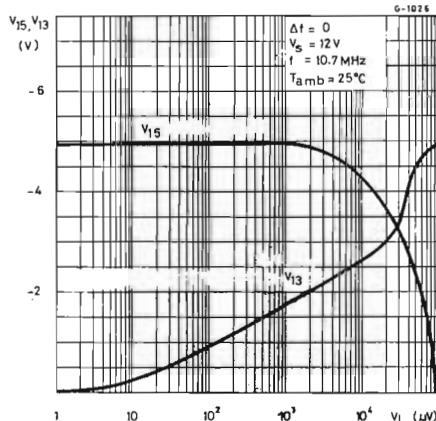
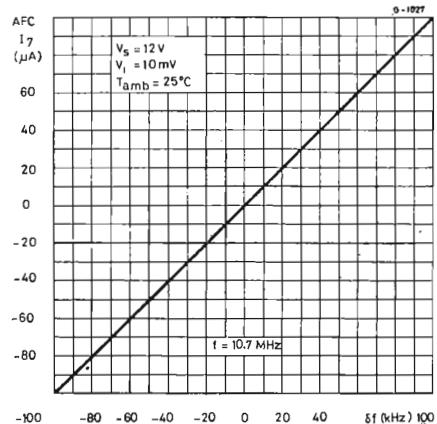
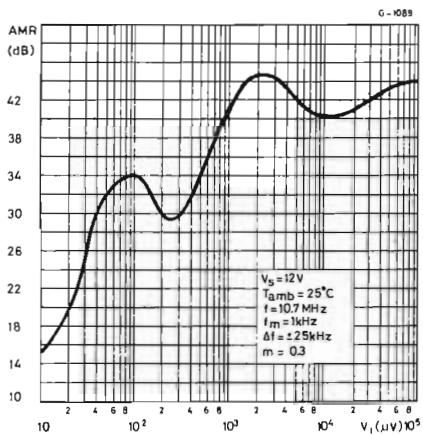
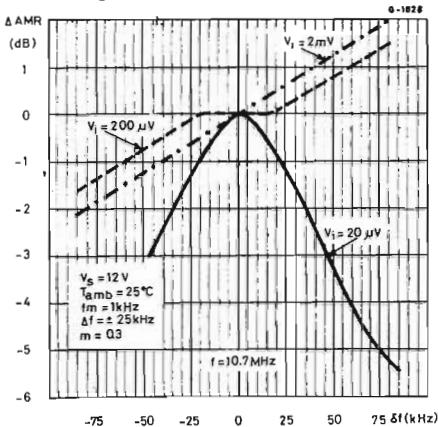
ELECTRICAL CHARACTERISTICS

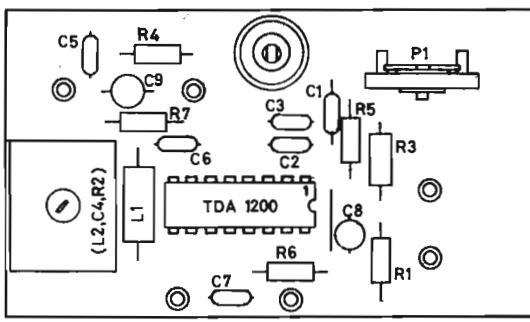
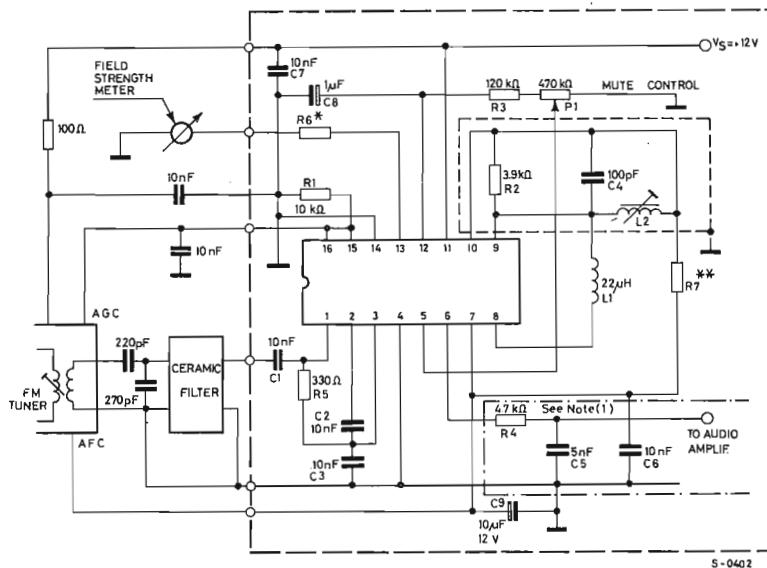
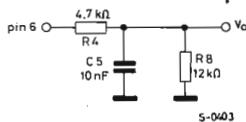
(Refer to the test circuit; $V_s = 12$ V, $T_{amb} = 25$ °C)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
STATIC (DC) CHARACTERISTICS						
I_s	Supply current			23		mA
V_1	Voltage at the IF amplifier input			1.9		V
V_2, V_3	Voltage at the input bypassing			1.9		V
V_6	Voltage at the audio output			5.6		V
V_{10}	Reference bias voltage			5.6		V

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
DYNAMIC CHARACTERISTICS						
$V_{i(threshold)}$	Input limiting voltage (-3 dB) at pin 1	$f = 10.7$ MHz $f_m = 1$ kHz $\Delta f = \pm 25$ kHz		12		μV
V_o	Recovered audio voltage (pin 6)	$V_i \geq 50$ μV $f = 10.7$ MHz $f_m = 1$ kHz $\Delta f = \pm 25$ kHz		140		mV
d	Distortion	$V_i \geq 1$ mV $f = 10.7$ MHz $f_m = 1$ kHz $\Delta f = \pm 75$ kHz		0.5		%
$\frac{S+N}{N}$	Signal and noise to noise ratio			60		dB
AMR	Amplitude modulation rejection	$V_i \geq 1$ mV $f = 10.7$ MHz $f_m = 1$ kHz $\Delta f = \pm 25$ kHz $m = 0.3$		40		dB
V_i	Input voltage for delayed AGC action(pin 1)			10		mV
$\frac{\Delta V_{15}}{\Delta V_i}$	AGC control slope	$V_i \geq 10$ mV $f = 10.7$ MHz		40		dB
$\frac{\Delta I_7}{\delta f}$	AFC control slope			1		$\frac{\mu A}{kHz}$
$\frac{\Delta V_{13}}{\Delta V_i}$	Field strength meter output slope			42		dB
V_{13}	Field strength meter output sensitivity	$V_i = 1$ mV $f = 10.7$ MHz		1.7		V

Typical recovered audio output and signal to noise ratio versus input voltage

Typical capture ratio versus input voltage

Typical AGC (V_{15}) and field strength meter output (V_{13}) versus input signal

Typical AFC output current versus change-in tuning frequency

Typical amplitude modulation rejection versus input signal

Typical AMR (relative to the value of f = 10.7 MHz) versus change-in tuning frequency

APPLICATIONS

PC board and component layout of the circuit on next page (1:1 scale).

Typical application circuit

NOTES: (1) When V_s is less than 12 V, a resistor R8 = 12 kΩ must be connected between audio output and ground, and the integrator capacitor C5 must be changed to 10 nF, as follows:

* Dependent on field strength meter sensitivity.

** Dependent on the tuner's AFC circuit.

LINEAR INTEGRATED CIRCUIT

SAJ 210

7-STAGE FREQUENCY DIVIDER FOR ELECTRONIC ORGANS

- HIGH CROSSTALK IMMUNITY - TYP. 70 dB
- OUTPUT SHORT CIRCUIT PROTECTION

The SAJ 210 is a monolithic integrated circuit in a 14-lead quad in-line or dual in-line plastic package. It has been created by means of the standard bipolar technique and especially developed for use as frequency divider for electronic organs. Seven flip-flops connected in 5 groups are housed on one silicon chip. The input and the output of each flip-flop is externally accessible.

ABSOLUTE MAXIMUM RATINGS

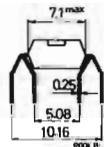
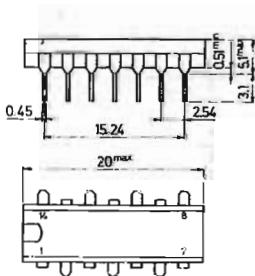
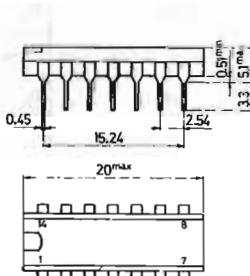
V_s	Supply voltage	14	V
V_i	Input voltage	$V_i = V_s$	
I_o*	Output current	5	mA
P_{tot}	Power dissipation at $T_{amb} \leq 70\ °C$	0.5	W
T_{stg}	Storage temperature	-55 to 125	°C
T_{op}	Operating temperature	0 to 70	°C

* With reference to Fig. 5, the current can be greater than 5 mA, but for $t < 0.1$ ms.

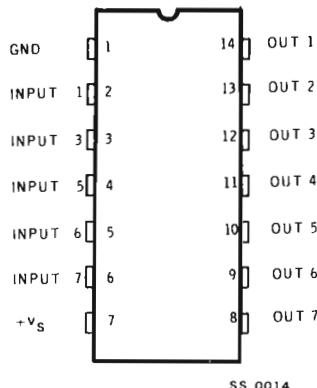
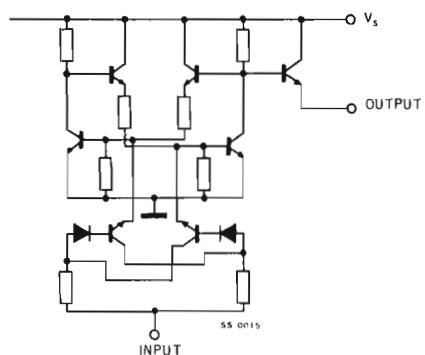
ORDERING NUMBERS:

SAJ 210 AX2 (for 14-lead quad in-line plastic package)
SAJ 210 AX7 (for 14-lead dual in-line plastic package)

MECHANICAL DATA

Dimensions in mm

SAJ 210 AX2

SAJ 210 AX7

SAJ 210

CONNECTION DIAGRAM
(top view)

SCHEMATIC DIAGRAM
(each flip-flop)

ELECTRICAL CHARACTERISTICS
(T_{amb} = 25 °C, V_s = 9 V unless otherwise specified)

	Parameter	Test conditions		Min.	Typ.	Max.	Unit
DATA INPUT							
V_{IL}	Input low level	V_s = 8 to 14 V		0		1.5	V
V_{IH}*	Input high level	V_s = 8 to 14 V		6			V
I_{IH}	Input high level current	V_i = 8 V			1	3	mA
DATA OUTPUT							
V_{OL}	Output low level	R_L = 3 kΩ				0.1	V
V	Output voltage impressed	Low level				6	V
V_{OH}	Output high level	R_L = 3 kΩ V_s = 12 V	 R_L = 3 kΩ	7 9.5			V V
t_r	Rise time	V_i = 8 V	C_L = 10 pF			0.1	µs
t_f	Fall time	R_L = 3 kΩ	C_L = 10 pF			0.2	µs
I_d	Total current drain	R_L = 3 kΩ All flip-flops at high level All flip-flops at low level			 35 16		 mA mA

ELECTRICAL CHARACTERISTICS (continued)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_o	Output swing	$R_L = 3\ k\Omega$		7.6		V
**	Cross talk immunity level	$R_L = 3\ k\Omega$ $C_L = 10\ pF$		70		dB
R_o	Dynamic output resistance	V_o impressed = 0 to 2 V at high level		160		Ω
		at low level	1	6		MΩ
	Ripple on output voltage at 2 f out	$V_i = 8\ V$		5		mV_{pp}

* Input high level is never reached if the input pulse is lower than 3.5 V.

** Two independent dividers are triggered
Divider A: triggering frequency 20 kHz
Divider B: triggering frequency 2240 Hz

$$\text{Cross talk level} = 20 \log \frac{V_o\ B\ 1120\ Hz}{V_o\ B\ 10\ kHz}$$

Fig. 1 - Typical input current vs input voltage

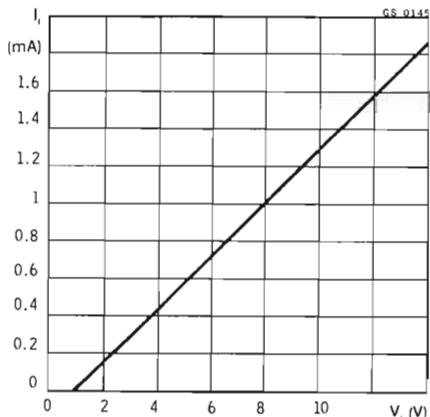



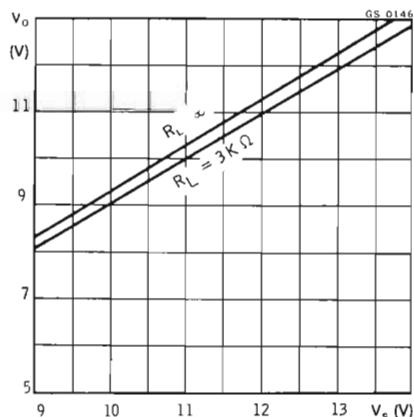
Fig. 2 - Typical output level vs supply voltage

SAJ 210

Fig. 3 - Typical input voltage for triggering

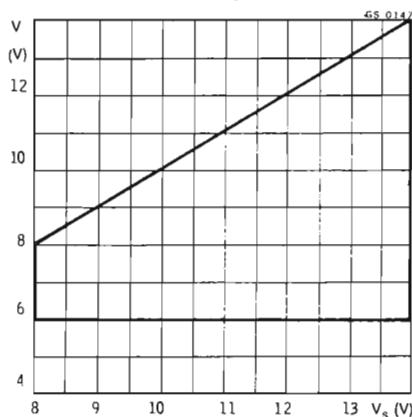



Fig. 4 - Power rating chart

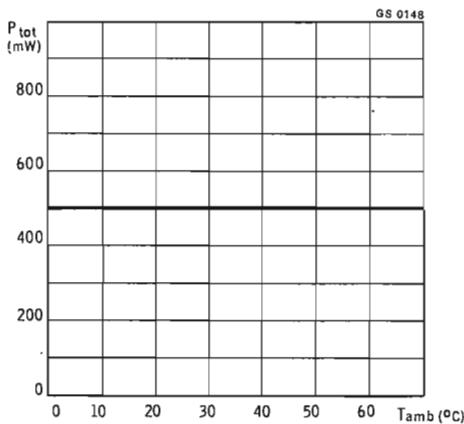



Fig. 5 - Typical output current vs output voltage

TYPICAL APPLICATIONS